3 DESCRIPTION OF AFFECTED ENVIRONMENT

3.1 Introduction

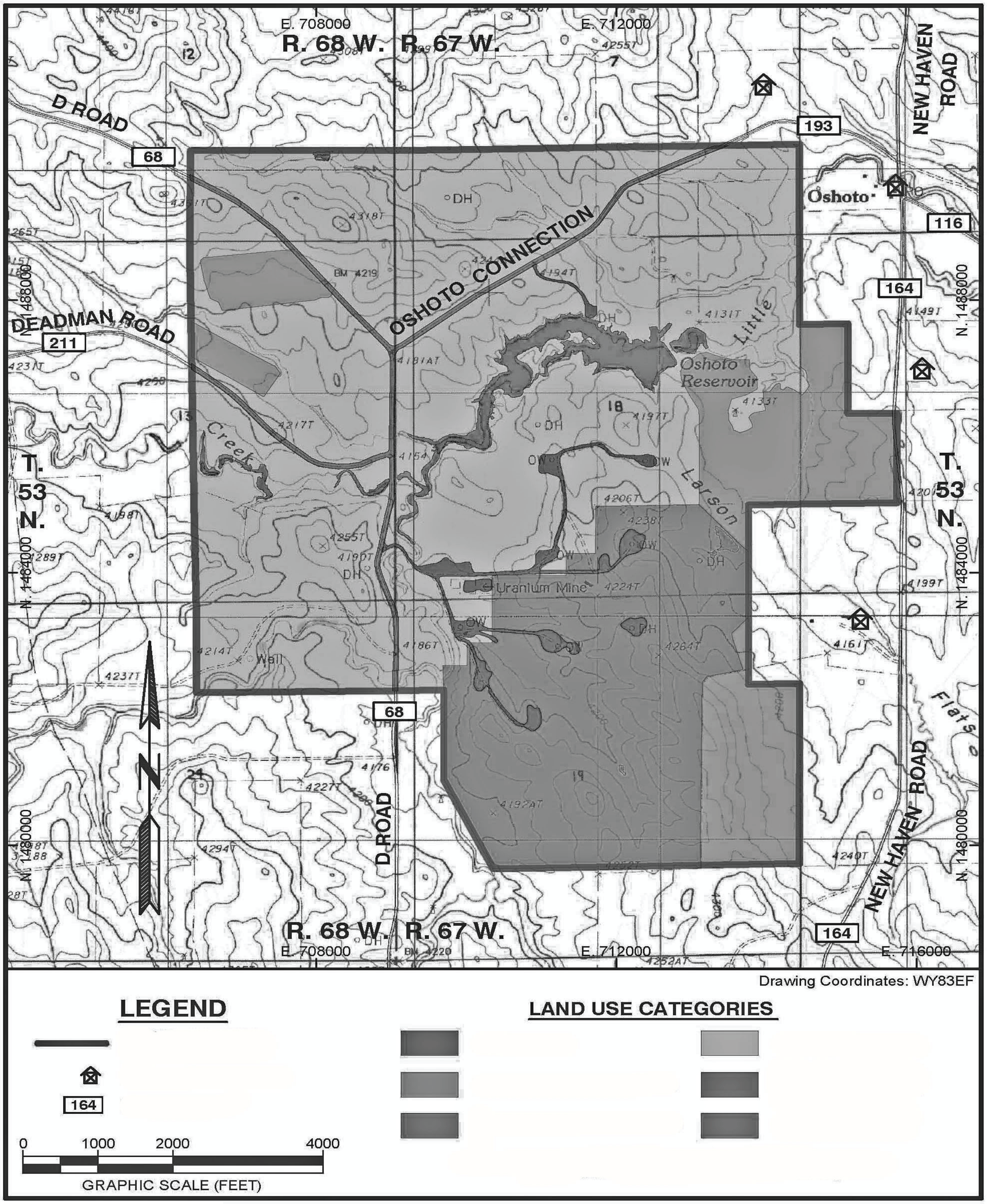
The Ross Project would be located in northeastern Wyoming, in a rural area of western Crook County, approximately 35 km [22 mi] north of the town of Moorcroft, Wyoming (see Figure 2.1 in SEIS Section 2). This section describes the existing conditions at the Ross Project area, the 697-ha [1,721-ac] area that is addressed in this Supplemental Environmental Impact Statement (SEIS), and its vicinity. The resource areas described in this section include land use; transportation; geology and soils; water, both surface water and ground water; ecology; noise; meteorology, climatology, and air quality; historical and cultural resources; visual and scenic resources; socioeconomics; public and occupational health and safety; and waste management. This description of the affected environment is based upon information provided in the Applicant's license application and its Responses to the U.S. Nuclear Regulatory Commission's (NRC's) Requests for Additional Information (RAIs) and supplemented by additional information identified by NRC and others in the public domain (Strata, 2011a; Strata, 2011b; Strata, 2012a; Strata, 2012b). The information in this section forms the basis for the evaluation discussed in Section 4, Environmental Impacts and Mitigation Measures, which discusses the potential impacts of the Proposed Action and of each of the Alternatives in each resource area, as defined in SEIS Section 2.1.

3.1.1 Relationship between the Proposed Project and the GEIS

As shown on Figure 2.3 in SEIS Section 2.1.1, the Ross Project area is located in the northern end and on the western edge of the Nebraska-South Dakota-Wyoming Uranium Milling Region (NSDWUMR), as defined in the GEIS (NRC, 2009b). However, in defining the NSDWUMR, the Generic Environmental Impact Statement (GEIS) focused on potential in situ recovery (ISR) sites located in the Black Hills area of South Dakota, which is east of the Ross Project area. As a result, some of the affected environment discussion in the GEIS for the NSDWUMR does not reflect actual site conditions at the Ross Project area (in particular, the subsurface geology and water resources information). However, the GEIS's discussion of the Wyoming East Uranium Milling Region (WEUMR), located west of the Ross Site, does provide germane information with respect to the Ross Project area's subsurface geology and water resources. These differences are described in the subsequent sections below.

3.2 Land Use

The Ross Project area encompasses approximately 697 ha [1,721 ac], as described in SEIS Section 2.1.1. Nearby towns include Pine Haven, 27 km [17 mi] southeast; Moorcroft, 35 km [22 mi] south; Sundance, 48 km [30 mi] southeast; and Gillette, 53 km [33 mi] southwest. The Ross Project area is adjacent to the unincorporated ranching community of Oshoto. There are 11 residences within 3 km [2 mi] of the Ross Project, but no residences within the Project area. The closest residence is approximately 210 m [690 ft] north-northeast of the Ross Project boundary (see Figure 3.1). Existing land uses include livestock grazing, oil production, crop agriculture, communication and power transmission infrastructure, transportation infrastructure,



Source: Strata, 2012a.

Figure 3.1

Current Land Use of Ross Project Area

limited recreational opportunities, stock and other reservoirs, and wildlife habitat (see Figure 3.2). The actual land ownership of the Ross Project area's surface differs from general land ownership in the region, in that 97.6 percent is owned by private landowners or the State of Wyoming, and 2.3 percent is owned by the Federal Government (as described in Section 3.3.1 of the GEIS, 53.3 percent of Wyoming land is public land). The proposed Ross Project facility would be located on private property, and the wellfields would be located on private, State, and Federal lands.

The State of Wyoming owns all of the mineral rights below State-owned land, and the Federal Government controls all of the mineral rights below U.S. Bureau of Land Management (BLM)-owned land. There are private lands where the Federal Government (through the BLM) controls the mineral rights below the Ross Project area, a situation known as a "split estate." Between land ownership and split estate, the Federal Government through the BLM therefore controls 11.7 percent of the total mineral rights under the Ross Project area (see Table 3.1), as opposed to 2.3 percent of the surface. All of the Federal rights are managed by the BLM.

Table 3.1
Distribution of Surface Ownership and Subsurface Mineral Ownership

Ownership	Surface Ownership		Subsurface Mineral Ownership	
	Ha / Ac	Percent	Ha / Ac	Percent
Private	553.3 / 1367.2	79.4	488.2 / 1206.4	70.1
State	127.1 / 314.1	18.2	127.1 / 314.1	18.2
Federal	16.2 / 40.0	2.3	81.3 / 200.9	11.7
TOTAL	696.6 / 1721.3	--	696.6 / 1721.3	--

Source: Strata, 2011a.

3.2.1 Pasture-, Range-, and Croplands

Approximately 95 percent of the Ross Project area is used for rangeland, cropland, or pastureland. The largest portion, over 80 percent, is rangeland, while 14 percent is used for agriculture. In Crook County, rangeland is primarily used for cattle, with some grazing of sheep. Crops grown in the vicinity include hay, oats, and wheat.

3.2.2 Hunting and Recreation

There are many hunting and recreational opportunities within Crook County. However, there are limited opportunities for hunting and recreation within the Ross Project area because the majority of the land is privately owned. The State-owned land within the Ross Project area is accessible from County Road (CR) 193, but the Federal BLM land is not served by public roads so the public cannot access the BLM land to hunt. Large-game hunting in the area includes antelope (North Black Hills herd), mule deer (Powder River and Black Hills herds), and white-tailed deer (Black Hills herd). Other hunting opportunities in the vicinity include sage-grouse, wild turkeys, and small game such as cottontail rabbits and snowshoe hares as well as red, gray, and fox squirrels. There are hunting seasons specific to each type of game; however, because of the predominantly private ownership of the land, hunting within the Ross Project area is limited.

Recreational areas in the Ross Project vicinity include Devils Tower National Monument (Devils Tower), Black Hills National Forest, and Keyhole State Park. These areas offer access to hiking, camping, boating, biking, horseback riding, fishing, and hunting. The nearest of these is Devils Tower, approximately 16 km [10 mi] east of the Ross Project.

Although native fish have been observed in the Oshoto Reservoir, there are no fisheries in the Ross Project area because of the ephemeral or intermittent nature of the streams. The Oshoto Reservoir is partially located on State land; however, the Wyoming Game and Fish Department (WGFD) does not stock the Reservoir and it is not managed by any private agencies. However, fishing has been reported downstream of the Little Missouri River, outside of the Ross Project area (Strata, 2011a).

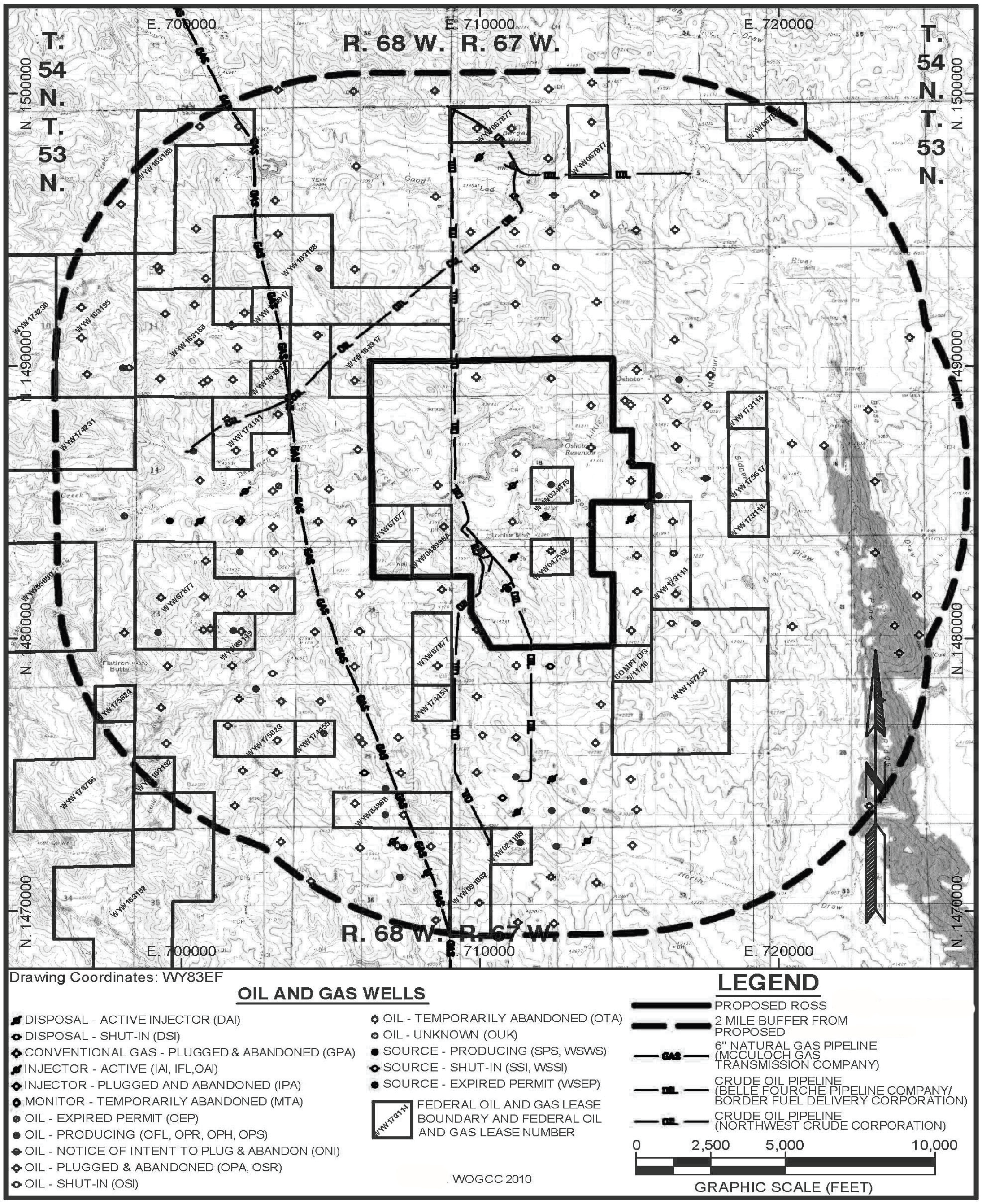
3.2.3 Minerals and Energy

There are three operating oil wells within the Ross Project area, producing from depths between 1,800 – 2,000 m [5,900 – 6,500 ft] below ground surface (bgs) (see Figure 3.2). Oil production is currently the only mineral extraction activity within the Ross Project area, although Crook County has other mineral resources which include coal, gas, bentonite (mine located 8 km [5 mi] to the northeast), sand, gravel, gypsum, and limestone in addition to uranium and vanadium.

There are currently no licensed or operating uranium-recovery facilities within 80 km [50 mi] of the proposed Ross Project, although four potential projects are under preliminary consideration and are in the very early planning stages (Strata, 2011a). These include the Bayswater Uranium Corporation's (Bayswater's) Elkhorn, Wyoming, project approximately 27 km [17 mi] to the northeast of the Ross Project area; Bayswater's Alzada, Montana, project at 58 km [36 mi] to the north-northeast; the UR-Energy/Bayswater's Hauber, Wyoming, project at 21 km [13 mi] to the north-northeast; and Powertech Uranium Corporation's (Powertech) Aladdin project at 64 km [40 mi] to the east-northeast (see Figure 3.3).

3.3 Transportation

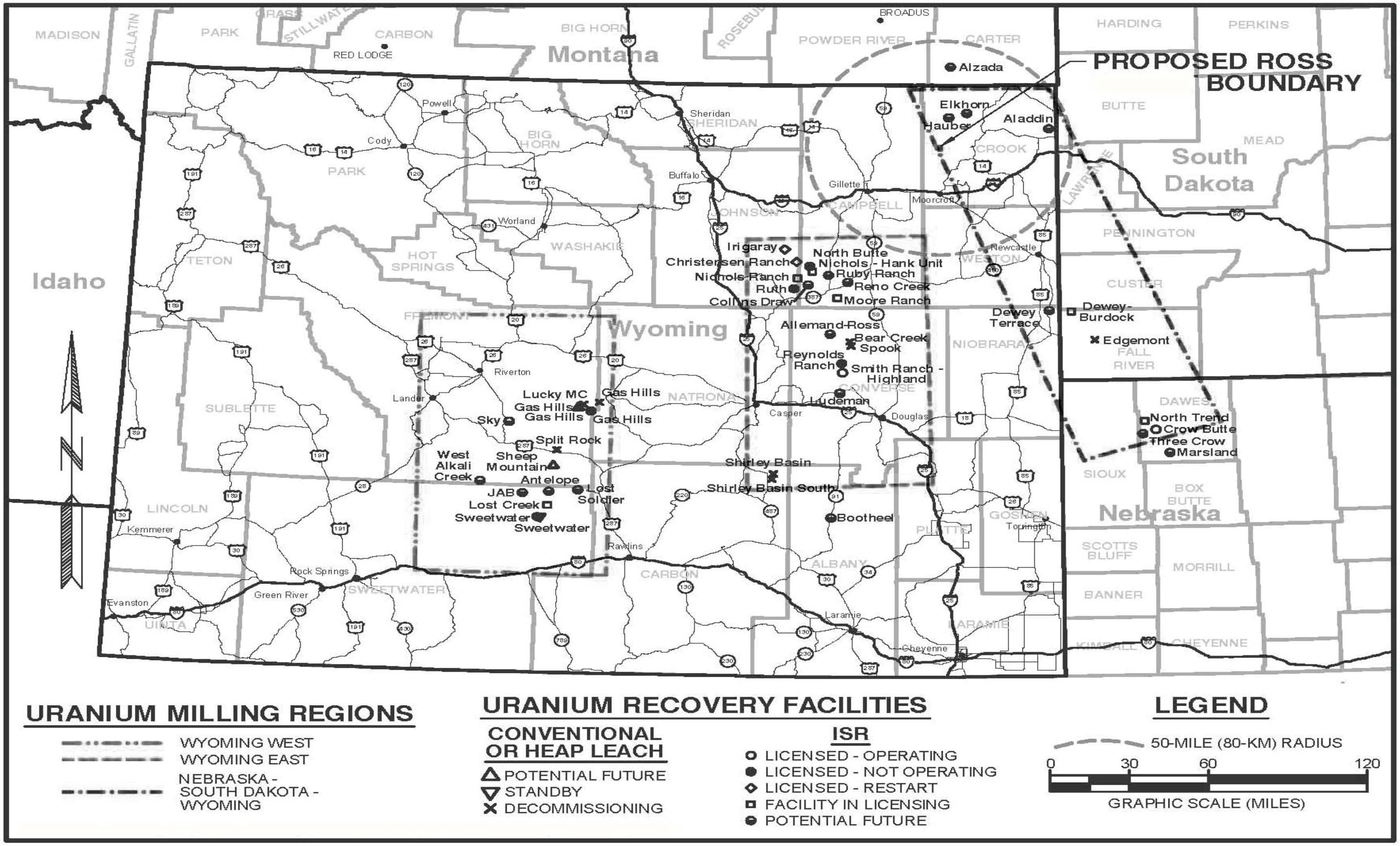
The Proposed Action would rely on existing roads for supply and material transport, workforce commuting, and yellowcake and waste shipments to and from the Ross Project. The existing transportation network is discussed in this section; Figure 3.4 depicts this network. The primary access road to the Ross Project area is from Exit 153 on I-90. From that point the Ross Project is reached by a vehicle's travelling south on US 14/16, west on WY 51, north on Bertha Road, north on CR 68 (also known as D Road), and north on CR 164 (also known as New Haven Road). The distance from the I-90 exit to D Road is 2.6 km [1.6 mi]. D Road is a two-lane asphalt and gravel road approximately 9 – 11 m [30 – 35 ft] wide with posted speed limits of 89 km/hr [55 mi/hr] for cars and 72 km/hr [45 mi/hr] for trucks. The asphalt pavement extends to 4.8 km [3 mi] north of Bertha Road, where it changes to a reclaimed-asphalt pavement, which has been rotomilled and blended with crushed base and subgrade. This surface continues for 11.7 km [7.3 mi] after which D Road has only a gravel surface. New Haven Road is a two-lane, crushed-shale road approximately 7.6 – 9.1 m [25 – 30 ft] wide, with a posted speed limit of 72 km/hr [45 mi/hr]. CR 193, also known as the Oshoto Connection, is a two-lane, crushed-shale



Source: WOGCC, 2010, as shown in Strata, 2012a.

Figure 3.2

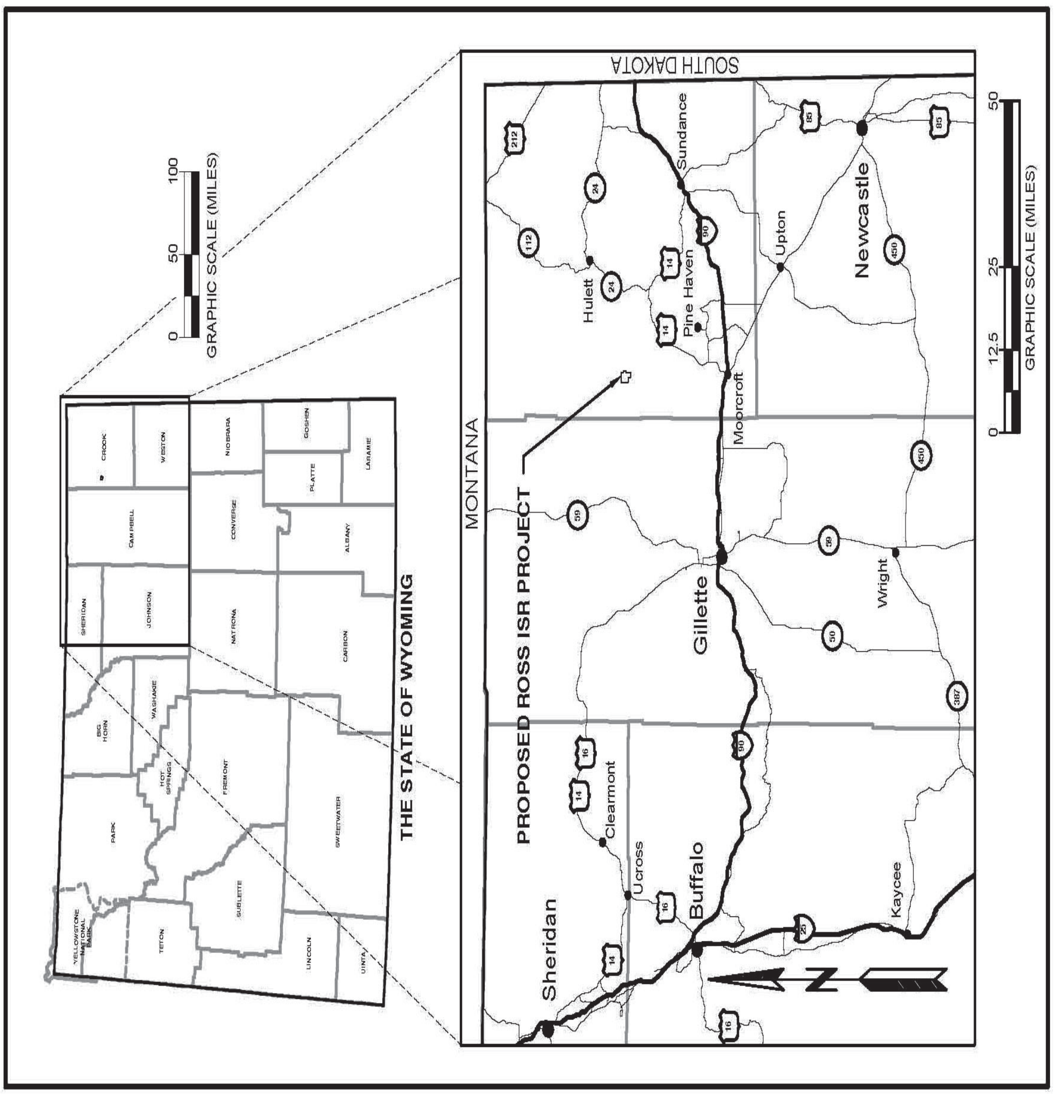
Oil and Gas Wells within Two Miles of Ross Project Area



1 Sources: Bayswater, 2010a; NRC, 2009b; NRC, 2010a; NRC, 2010b; Powertech, 2010; and UR-Energy, 2010 as shown in Strata, 2012a.

Figure 3.3

Existing and Planned Uranium-Recovery Facilities



Source: Strata, 2012a.

Figure 3.4
Existing Transportation Network in Northeast Wyoming

road that connects New Haven Road to D Road along the northern portion of the Ross Project area. Other county roads in the local vicinity that can be used to access the Ross Project area include CR 26 (Cow Creek Road), CR 91 (Spring Creek Road), and CR 211 (Deadman Road). Figure 2.1 shows the relative locations of these roads. Crook County conducts year-round routine maintenance of all CRs, including snow and debris removal, blading and grading, and miscellaneous repair.

The Applicant has completed traffic studies on the county roads near the Ross Project area (Strata, 2011a), as has the State of Wyoming for its highways (see Table 3.2). Much of the existing truck traffic on the CRs adjacent to the Ross Project is due to local oil- and gas-recovery activities as well as to a bentonite mine approximately 8 km [5 mi] northeast of the Project.

Table 3.2
Traffic Volumes on Roads and Highways in Vicinity of Ross Project Area (2010)

Road/Highway	Vehicles per Day	
	All Vehicles	Trucks
I-90 at Moorcroft	4,744	906
New Haven Road South of Ross Project Area	108	10.8
New Haven Road South of Oshoto Connection	138	11
On-Site Measurements		
D Road South of Deadman Road	25	1.5
D Road North of Deadman Road	49	2.3
D Road North of Oshoto Connection	62	6.2
Oshoto Connection between D Road and New Haven Road	87	11.3

Sources: Strata, 2011a, and Wyoming Department of Transportation (WYDOT), 2011.

3.4 Geology and Soils

The Lance District, which includes the Ross Project area (refer to Figure 2.1), is structurally situated between two major tectonic features: the Black Hills uplift to the east and the Powder River Basin to the west (Strata, 2011a). Both of these regional features are described in the GEIS (NRC, 2009b). The Black Hills uplift is generally allocated to the NSDWUMR, and the Powder River Basin to the WEUMR. The Project area’s structural geology, stratigraphy, uranium mineralization, and seismology as well as the types and characteristics of the soils present at the Project area are described in this section.

3.4.1 Ross Project Geology

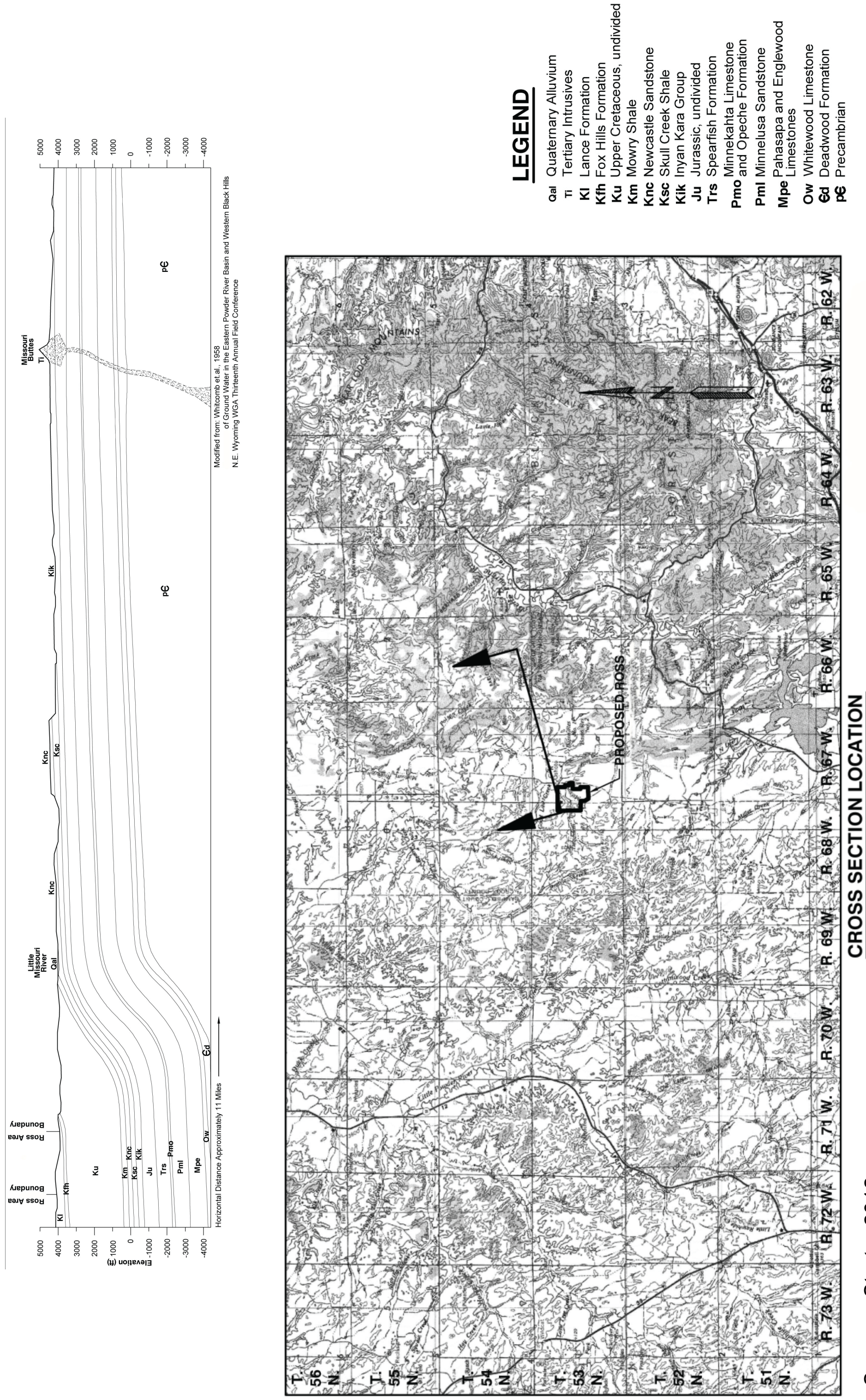
The uranium-bearing units targeted for recovery within the Ross Project area are located in permeable sandstones of the Late Cretaceous Lance and Fox Hills Formations. The uranium roll fronts deposited in the Oshoto area demonstrate patterns similar to those across the Powder River Basin. The Ross Project area's roll fronts were created by precipitation of uranium from ground water as a coating on sand grains primarily due to changes in aquifer conditions and ground-water flow (Buswell, 1982). The roll-front geometry at the Project area can vary as a result of differences of the host sandstones. The deeper Fox Hills roll fronts are generally thicker and more massive due to the near-shore environment into which the sediments were deposited. The lower Lance Formation sandstones were deposited in a fluvial environment (i.e., deposited by rivers or streams), resulting in narrower, often stacked channel systems containing uranium mineralization. Because of the variability of the depositional environment, the roll fronts near or at the Ross Project area are complex, and new exploration activities consistently yield increasing total uranium estimates. At this time, estimates of recoverable uranium within the Ross Project area exceed 2,495 t [5.5 million lb] of uranium and, based on current projections, these estimates are likely to increase as more exploration and characterization results become available.

3.4.1.1 Structural Geology

The Black Hills uplift is a broad north-trending dome-like structure approximately 290 km [180 mi] long (north to south) and 121 km [75 mi] wide (west to east) whose core is composed of Precambrian basement rocks (NRC, 2009b). The western flank of the uplift is characterized by a monoclinal (a one-limbed or step-like flexure) break near the Ross Project area (Lisenbee, 1988). The eastern edge of the Ross Project area lies along the hinge of the Black Hills monocline. Because of the Black Hills monocline, the regional stratigraphic dip goes from essentially horizontal within the Powder River Basin, to steeply dipping along the eastern edge of the Ross Project area (see Figure 3.5). As indicated in the bedrock geologic map, Figure 3.6, the entire Ross Project area lies within the outcrop of the Lance Formation. The Cretaceous Formations below the Lance Formation all outcrop within roughly 3 km [2 mi] east of the Ross Project area.

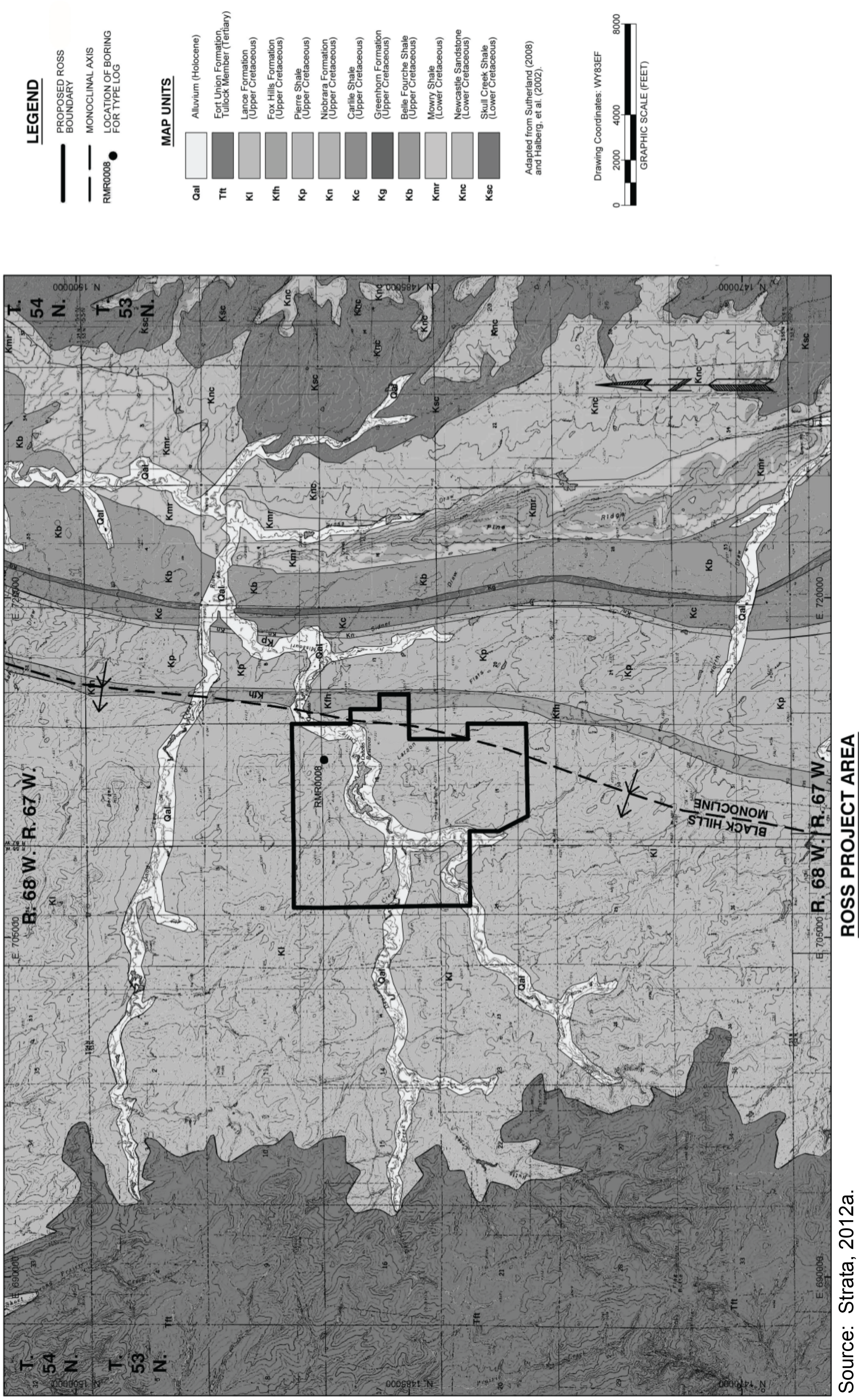
Devils Tower, which is discussed later in the visual and scenic resources section of this section (Section 3.10), is located approximately 16 km [10 mi] east of the Ross Project area. Devils Tower and the Missouri Buttes (15 km [9.5 mi] northeast of the Ross Project) are geologic features formed by the intrusion of igneous material (i.e., magma) through the earth's crust during the Tertiary Period (i.e., subsequent to the deposition of the upper Cretaceous formations hosting the Lance District's uranium deposits) (Robinson, 1964).

With the exception of the Black Hills monocline, there are no significant structural features within the Ross Project area. No faults of major displacement are known to exist within the Ross Project area; however, minor localized slumps, folds, and differential compaction features that formed shortly after deposition are common (Strata, 2011a).



Source: Strata, 2012a.

Figure 3.5
Generalized Cross Section of Black Hills Monocline in the Oshoto Area



Source: Strata, 2012a.

Figure 3.6
Surface Geology of Ross Project Area

3.4.1.2 Stratigraphy

Stratigraphy describes the layers of rocks and soils below the ground's surface (i.e., the subsurface) that host the ore zone as well as the layers of rock that separate the ore zone from the aquifers above and below it. An analysis of the local stratigraphy is used in assessments of whether the ore zone is adequately confined above and below by rock layers of low permeability that would prevent vertical movement of water from the ore zone.

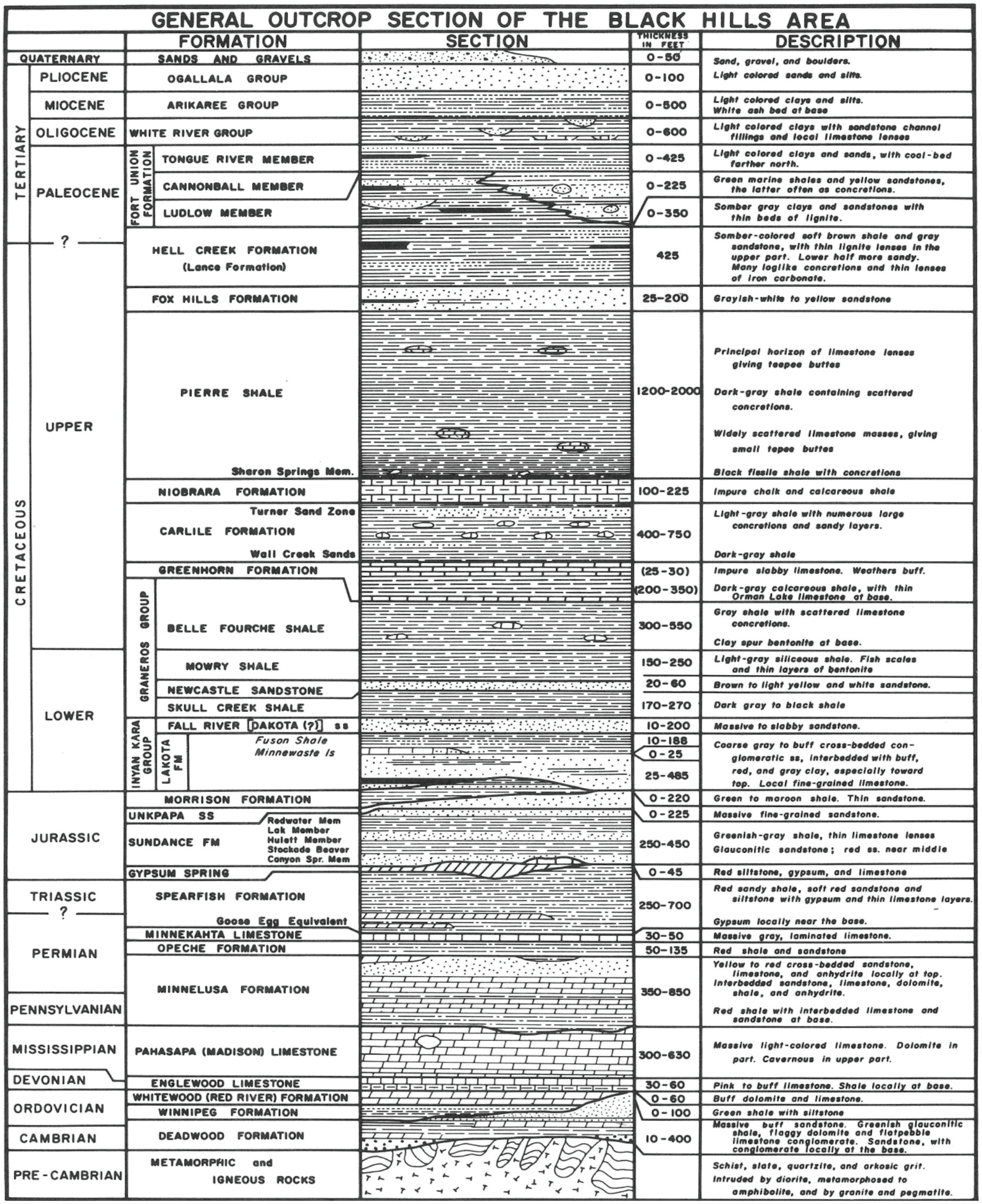
The regional stratigraphy of the Black Hills area is shown in Figure 3.7. The ore zone, which would be the "production zone" (i.e., the deposits from which uranium would be recovered) at the Ross Project, is within the upper Cretaceous stratigraphic units, including the lower Lance (Hell Creek) and upper Fox Hills Formations.

Detailed analysis of the subsurface stratigraphy and mineralogy of the Ross Project area began with the first uranium exploration and development efforts in the Oshoto area during the 1970s by the Nubeth Joint Venture (Nubeth) as described in SEIS Section 2.1.1 (Strata, 2011a). In 2008 and 2009, the Applicant began confirmation and exploration drilling at the Ross Project (Strata, 2011a). As of October 2010, the Applicant possessed information from the 1,682 holes drilled by Nubeth as well as its own 540 recent exploration drillholes, which are all located within a 0.8-km [0.5-mi] radius of the Ross Project area. The logs of these drillholes were used by the Applicant to characterize the site-specific stratigraphy of the Ross Project area (Strata, 2011a; Strata, 2011b).

The Pierre Shale in this area is a massively bedded, relatively uniform, thick marine shale that is considered a regional confining layer (or "unit" or "interval") (NRC, 2009b). This unit outcrops approximately 0.4 km [0.3 mi] east of the Ross Project's eastern boundary (see Figure 3.6). Based upon the width of the outcrop and geophysical logs from oil wells located in the general area, the Applicant has estimated the thickness of the Pierre Shale to be approximately 670 m [2,200 ft] thick under the Ross Project area (Strata, 2011a; Robinson, 1964). Because of its thickness and low permeability, the Pierre Shale is considered the lower ground-water-confining unit within the Ross Project vicinity, separating the older, deeper Formations below the Pierre Shale from the Ross Project's target ore zones which are in the overlying Fox Hills and Lance Formations.

Below the Pierre Shale, the Cambrian-age Deadwood and Flathead Formations are encountered at depths of approximately 2,490 – 2,600 m [8,160 – 8,560 ft] bgs (WDEQ/WQD, 2011). The Applicant proposes that these Formations are the optimum target interval for the Underground Injection Control (UIC) Class I deep-injection wells that would be used for waste-water disposal at the Ross Project. The Applicant has already received its UIC Class I Permit for this type of disposal (Strata, 2011a).

The Fox Hills Formation, which lies between the Pierre Shale and the Lance Formation, outcrops along the proposed eastern boundary of the Ross Project (refer to Figure 3.6). The Fox Hills Formation is a sequence of marginal marine to estuarine sand deposits that were deposited during the eastward regression of the upper Cretaceous interior seaway (Dunlap, 1958; Merewether, 1996). In the vicinity of Oshoto, the Fox Hills Formation is divided into lower and upper units, which are based on differences in color, bedding, trace fossil concentrations, lithology, and texture (Dodge and Spencer, 1977).



Source: South Dakota School of Mines, 1963.

Figure 3.7

Regional Stratigraphic Column of Area Containing the Lance District

Above the Fox Hills Formation, the Lance Formation has been interpreted as being fluvio-deltaic in origin, consisting of a mixture of non-marine-deposited sandstones and floodplain mudstones with thin beds of coal (Connor, 1992). This depositional environment created a stratigraphic sequence of shale, mudstones, and sandstones that is complicated and vertically heterogeneous (Dodge and Powell, 1975).

The horizontal continuity of the various stratigraphic intervals beneath the Ross Project is clearly depicted on the geologic cross-sections and fence diagrams provided by the Applicant (Strata, 2011a; Strata, 2012b). The upper Fox Hills and lower Lance Formations are stratigraphically continuous and hydraulically isolated from the overlying upper Lance Formation by continuous and impermeable mudstones and claystones as well as from the underlying units by the basal Fox Hills siltstone-claystone interval and the Pierre Shale.

3.4.2 Soils

Soils at the Ross Project are typical for semi-arid grass- and shrublands in the western U.S. (Strata, 2011a). Most of these soils are classified as Aridic Argiustolls, Ustic Haplargids, or Ustic Torrifluvents that were derived from the Lance Formation over time.

General topography of the Ross Project area ranges from nearly level uplands to steep hills, ridges, and breaks. The soils occurring on hills, ridges, and breaks at the Ross Project are generally sandy or coarse texture with clayey or fine-textured soils occurring on nearly level uplands and near drainages. The Ross Project area contains moderate and deep soils on level upland areas and drainages with shallow soils located on hills, ridges, and breaks. Figure 3.8 depicts the types of pre-licensing baseline soils located on the Ross Project area (Strata, 2011a; Strata, 2012b). The area of the Ross Project is about equally divided between sandy loam soils and clay loam soils (Strata, 2011a; Table 2.6-9 in Strata, 2012b). The soil characteristics of both the Proposed Action’s south site (Alternative 1) and the north site (Alternative 3) are of particular interest since these would be the largest areas of soils disturbance during the Ross Project (see Table 3.3).

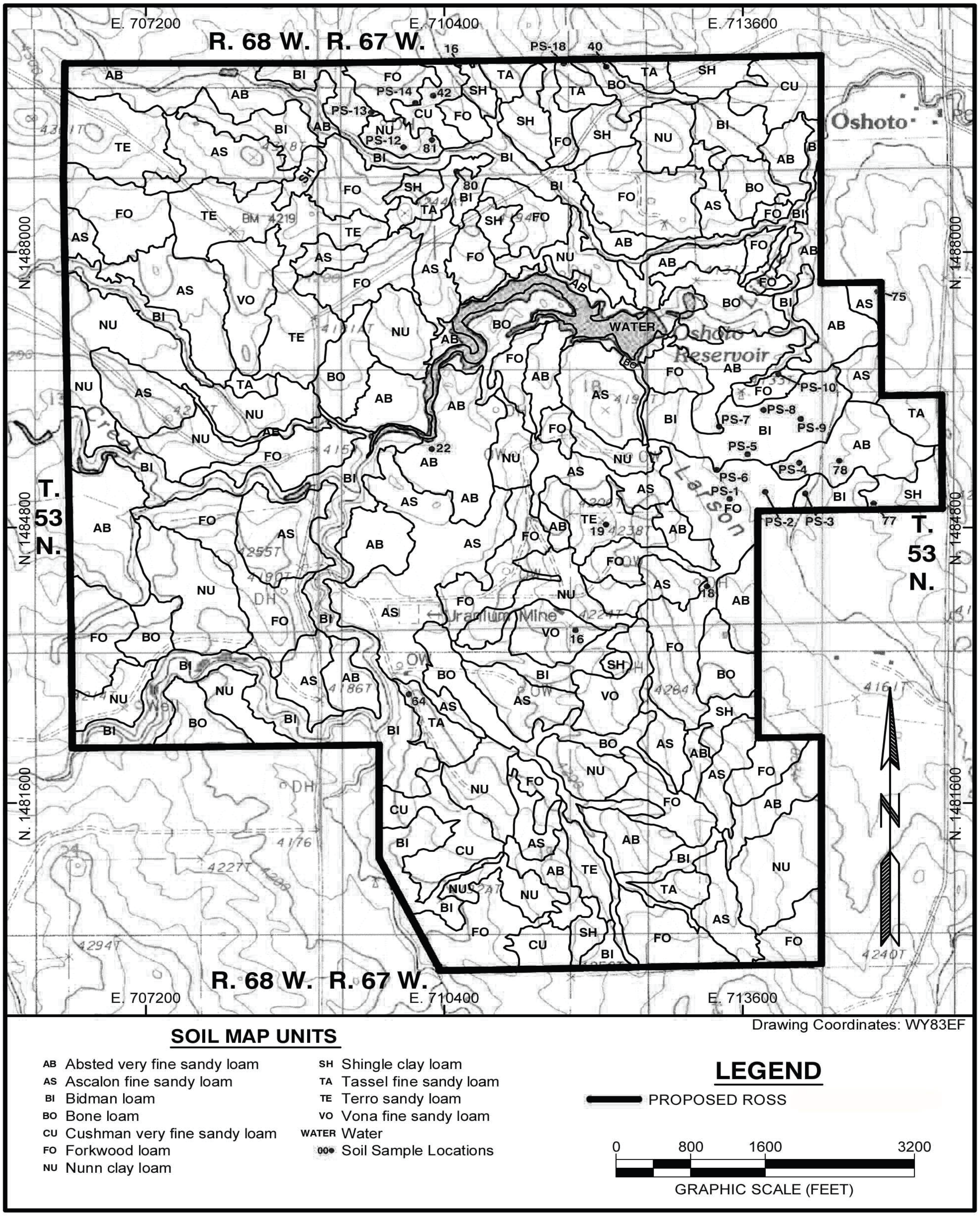
Approximate topsoil salvage depths range from 0.13 – 1.5 m [0.42 – 5 ft] with an average of 0.5 m [1.7 ft]. Factors that affect the suitability of a soil as a vegetation-growth medium are: texture, soil-adsorption ratio (SAR), electrical conductivity (EC), and pH as well as selenium and calcium carbonate concentrations. Based upon a comparison of laboratory analysis results and field observations with the respective Wyoming Department of Environmental Quality (WDEQ)/Land Quality Division (LQD) standards, suitable and marginally suitable material was found in 19 of the 26 samples within the Ross Project area (Strata, 2011a; WDEQ/LQD, 1994); unsuitable material was found in 7 of the 26 samples. The parameters that exceeded topsoil suitability criteria in those seven samples were high clay texture, high SAR, alkaline pH, and high concentration of selenium.

The hazard for wind and water erosion at the Ross Project varies from negligible to severe, based upon the soil-mapping descriptions. The potential for wind and water erosion is primarily dependent on the surface characteristics of the soils, including texture and organic-matter content. Given the slightly coarser texture of the surface horizons at the majority of the Ross Project, the soils are slightly more susceptible to erosion from wind than water.

Table 3.3 Soil Coverage and Characteristics for Ross Project Area					
Soil Name	**Soil Map Symbol**	**Alternative 1 (South) Site (ha [ac])**	**Alternative 3 (North) Site (ha [ac])**	**Water Erosion Hazard**	**Wind Erosion Hazard**
Absted very fine sandy loam	AB	3.7 [9.1]	N/A	Moderate	Moderate
Bidman loam	BI	9.3 [23.1]	2.2 [5.4]	Moderate	Moderate
Cushman very fine sandy loam	CU	N/A	2.0 [5.0]	Moderate	Slight
Forkwood loam	FO	7.1 [17.5]	3.4 [8.4]	Moderate	Slight
Nunn clay loam	NU	N/A	2.4 [5.9]	Slight	Slight
Shingle clay loam	SH	N/A	2.3 [5.7]	Moderate	Moderate
Tassel fine sandy loam	TA	N/A	2.7 [6.7]	Slight	Moderate

Source: Strata, 2011a.
Notes:
N/A = The type of soil is not present at the south or north site as indicated.
"Water Erosion Hazard" describes the susceptibility of the soil type to erosion by water, and "Wind Erosion Hazard" describes the susceptibility of the soil type to erosion by wind.

Although laboratory analyses for non-radioactive, chemical constituents in the soils at the Ross Project are not required by WDEQ/LQD to establish pre-operational baseline values, radioactive constituents in some soils were measured in order to establish such a pre-licensing baseline for radioactive species concentrations. These concentrations of specific radioactive elements are presented in Table 3.21 (see Section 3.12.1).



Source: Strata, 2012a.

Figure 3.8

Soil Mapped Units at Ross Project Area

3.4.3 Uranium Mineralization

What are the characteristics of uranium deposits that make them amenable to in situ uranium recovery?

Certain geologic and hydrological features make a uranium deposit in an ore zone suitable for in situ uranium recovery (based on Holen and Hatchell, 1986, as cited in NRC, 2009b):

- **Deposit geometry:** For ISR operations, the wellfield boundaries are defined based upon the geometry of the specific uranium mineralization. The deposit should generally be horizontal and have sufficient size and lateral continuity to enable economic uranium extraction.
- **Permeable host rock:** The host rock of the ore-zone aquifer must be permeable enough to allow the solutions (the lixiviant) to access and interact with the uranium mineralization. Preferred flow pathways, such as fractures in the rock, may short circuit portions of the mineralization and reduce the recovery efficiency. The most common host rocks are sandstones.
- **Confining layers:** Hydrogeologic (formation) geometry must prevent lixiviant from vertically migrating. Typically, low permeability layers such as shales or clays "confine" the uranium-bearing sandstone(s) both above and below. This confinement isolates the uranium-producing zone from overlying and underlying aquifers.
- **Saturated conditions:** For ISR uranium-recovery techniques to work, the uranium mineralization should be located in a hydrologically saturated zone (in an aquifer).

The process of uranium mineralization in the Lance District in general and specifically at the Ross Project is consistent with the characteristics of the uranium deposits that are identified in the GEIS as amenable to in situ uranium recovery. This mineralization includes fluvial sandstones (NRC, 2009b).

The lithological variability within the upper Fox Hills and Lance Formations would allow the geometric definition of ore deposits (i.e., areas of uranium mineralization) with sufficient size and continuity to make economic recovery viable. The saturated sandstone lithology of the ore zone would provide adequate permeability to allow uranium-recovery solutions access and interaction with uranium in the ore zone. In addition, the presence of impermeable intervals above and below the ore zone would prevent vertical migration of lixiviant or other fluids. Thus, the geology of the deposits would provide the characteristics required for an effective uranium-extraction project.

The mineralogy and petrography determined by the Applicant indicated that the ore zone is suitable for ISR (Strata, 2011a). The sandstone in the ore zone consists of 60 percent quartz, 35 percent feldspar, 5 percent montmorillonite clay, approximately 1 percent organic material, and less than 1 percent of pyrite and carbonate minerals (Strata, 2011a). The presence of pyrite confirms the geochemical conditions necessary for formation of the roll front. Petrographic analyses show that the ore zone has sufficient porosity (or reservoir quality) for movement of lixiviant from injection to recovery wells (Strata, 2011a). The ore zone is composed of fine grained, moderately well sorted, argillaceous sandstone with subangular to subrounded grains that are lightly to moderately compacted.

Consistent with the GEIS and typical of roll-front deposits (NRC, 2009b), analysis of the samples from the ore zone at the Ross Project shows that the principal uranium minerals are uraninite, an uranium oxide (UO_2), and coffinite, an uranium silicate ($U[SiO_4][OH])_4$) (Strata, 2011a). Vanadium in the form of vanadinite (a lead chlorovanadate [$Pb_5\{VO_4\}_3Cl$]) and carnotite [a hydrated potassium uranyl vanadate ($K_2[UO_2]_2[VO_4]_2\ 3H_2O$)] is also found in association with the uranium at an average ratio of 0.6 (vanadium) to 1.0 (uranium).

3.4.4 Seismology

There are no active faults with surface expression mapped within or near the Ross Project, according to the U.S. Geological Survey (USGS) (USGS, 2011). The closest capable faults to the Project area are located in central Wyoming, 270 km [170 mi] to the west-southwest. Six east-west trending structural faults through the Ross Project area were mapped by Buswell (1982). These faults are due to heterogeneity of the lithology among the shale and sandstone intervals within the upper Cretaceous Formations. However, these were based upon limited observations and information from one core sample and one aquifer test. The Applicant's examination of multiple geological cross-sections developed from stratigraphic information obtained from exploration drillholes do not appear to support this interpretation of the Ross Project area's faults (see SEIS Section 3.4.1.2) (Strata, 2011a).

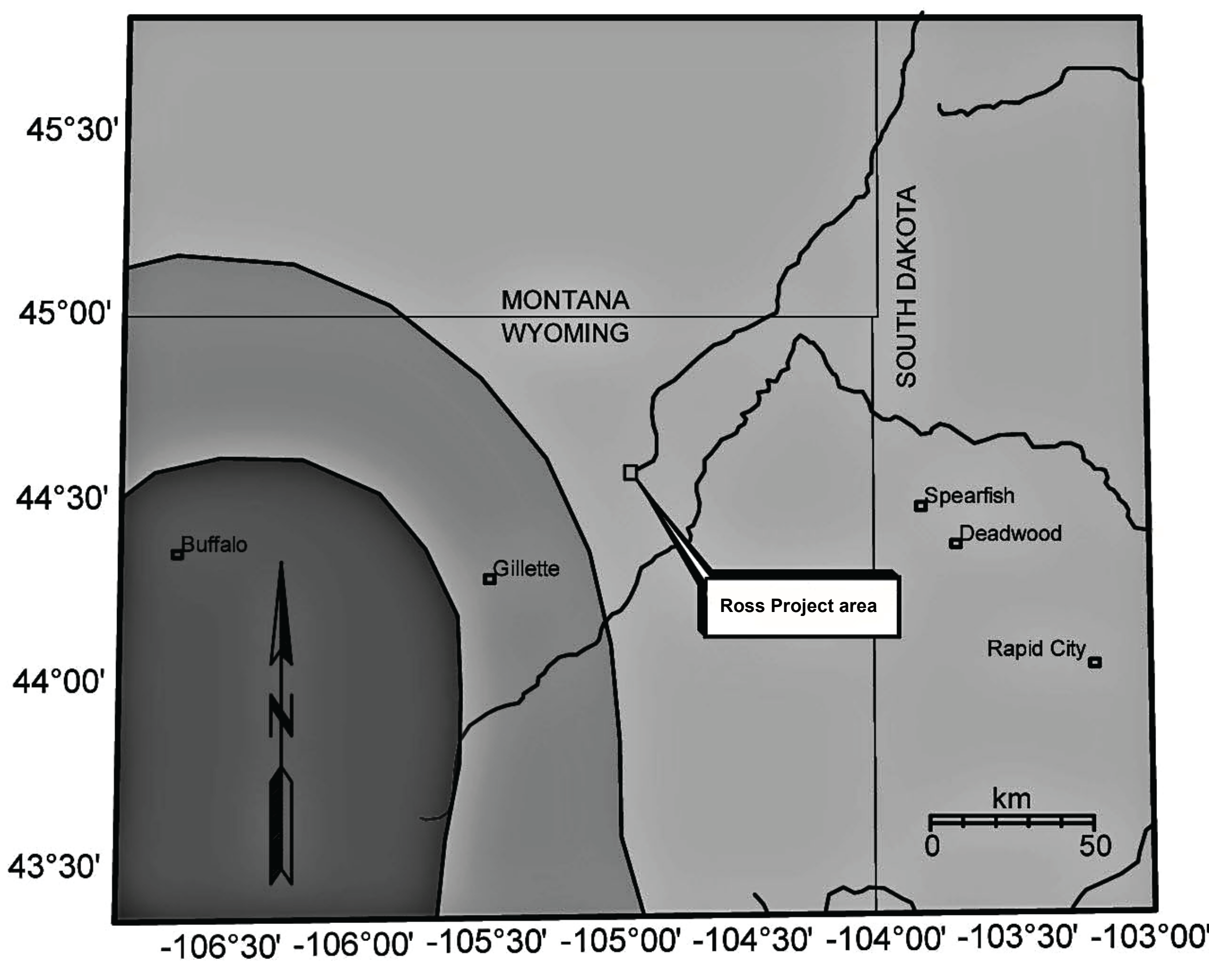
Two earthquakes with magnitudes greater than 2.5 (on the Richter Magnitude Scale) have been recorded in Crook County and nine in Campbell County (Strata, 2011a). Of those with magnitudes greater than 2.5, 3 had magnitudes 3.0 and greater (Case, Toner, and Kirkwood, 2002). The first reported earthquake in Crook County with a magnitude of greater than 3 occurred near Sundance on February 3, 1897, severely shaking the Shober School on Little Houston Creek southwest of Sundance. On November 2004, an earthquake of magnitude of 3.7 was recorded near Moorcroft in Crook County. On February 18, 1972, a magnitude 4.3 earthquake occurred approximately 30 km [18 mi] east of Gillette near the Crook-Campbell County line (Case, Toner, and Kirkwood, 2002). No damage was reported. The occurrence of few, low-magnitude events is consistent with the predicted low probability of seismic-induced or earthquake-caused ground motion in northeastern Wyoming (Algermissen et al., 1982).

Earthquakes generally do not result in ground-surface rupture unless the magnitude of the event is greater than 6.5 (Case and Green, 2000). Because of this, areas of Wyoming that do not have active faults exposed at the surface, such as the Ross Project area, are generally thought not to be capable of having earthquakes with magnitudes over 6.5. As shown on Figure 3.9, the probability of an earthquake with magnitude greater than or equal to 6.5 in the vicinity of the Ross Project is less than 0.001. This figure was prepared using the USGS Probabilistic Seismic Hazard Analysis (PSHA) model (USGS, 2010). Earthquakes with magnitudes less than 6.5 would cause little damage in specially built structures, but they could cause considerable damage to ordinary buildings and even severe damage to poorly built structures. Some walls could collapse, but underground pipes would generally not be broken, and ground cracking would not occur or would be minor (USGS, 2010).

3.5 Water Resources

Water resources in the vicinity of Ross Project include both surface water and ground water. Both the quantity and the quality of both surface and ground waters are described in this section.

Pre-licensing baseline water-quality data have been collected and analyzed by the Applicant in accordance with the following guidelines:



1 Source: Strata, 2011a.

Note: Darkest shaded area indicates probability between 0.003 and 0.002; lighter shaded area indicates probability between 0.002 and 0.001; lightest shaded area indicates probability between 0.001 and 0.000.

Figure 3.9

Probability of Earthquake with Magnitude of Greater Than or Equal to 6.5 in 50 Years

- American Society for Testing and Materials (ASTM) International's Standard D449-85a, *Standard Guide for Sampling Groundwater Monitoring Wells*, as recommended in the NRC's guidance document, NUREG–1569, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications* (NRC, 2003). This ASTM Standard was replaced by ASTM Standard D4448-01 in 2007.
- WDEQ's "Hydrology, Coal and Non Coal," Guideline No. 8 (WDEQ/LQD, 2005b).
- NRC's Regulatory Guide 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills*, Revision 1 (NRC, 1980).

These guidance documents by both NRC and WDEQ recommend water samples be filtered before the analysis of any metals each sample might contain. ASTM D449-85a (now ASTM 4448-01) and the NRC's Regulatory Guide 4.14 also specify analysis of radiological parameters in filtered samples (NRC, 1980). The results of the analysis of constituents in filtered samples are then reported as "dissolved" concentrations (versus "unfiltered" samples, which are reported as "total" concentrations). The filtering of water samples before analysis for metals is consistent with WDEQ/WDQ's *Groundwater Sampling for Metals: Summary*, which explains that filtering samples eliminates bias that may arise from variable turbidity in the samples (WDEQ/WQD, 2005a). The NRC's guidance on filtering samples applies to both pre-licensing baseline site-characterization monitoring efforts as well as post-licensing, pre-operational and operational environmental monitoring efforts during ISR operation and aquifer restoration.

The standardized protocol for filtering samples that will be analyzed for metals also allows a sound comparison among other data sets. For example, pre- and post-ISR operation water-quality data available for Nubeth also reported dissolved metal concentrations (i.e., filtered samples were analyzed).

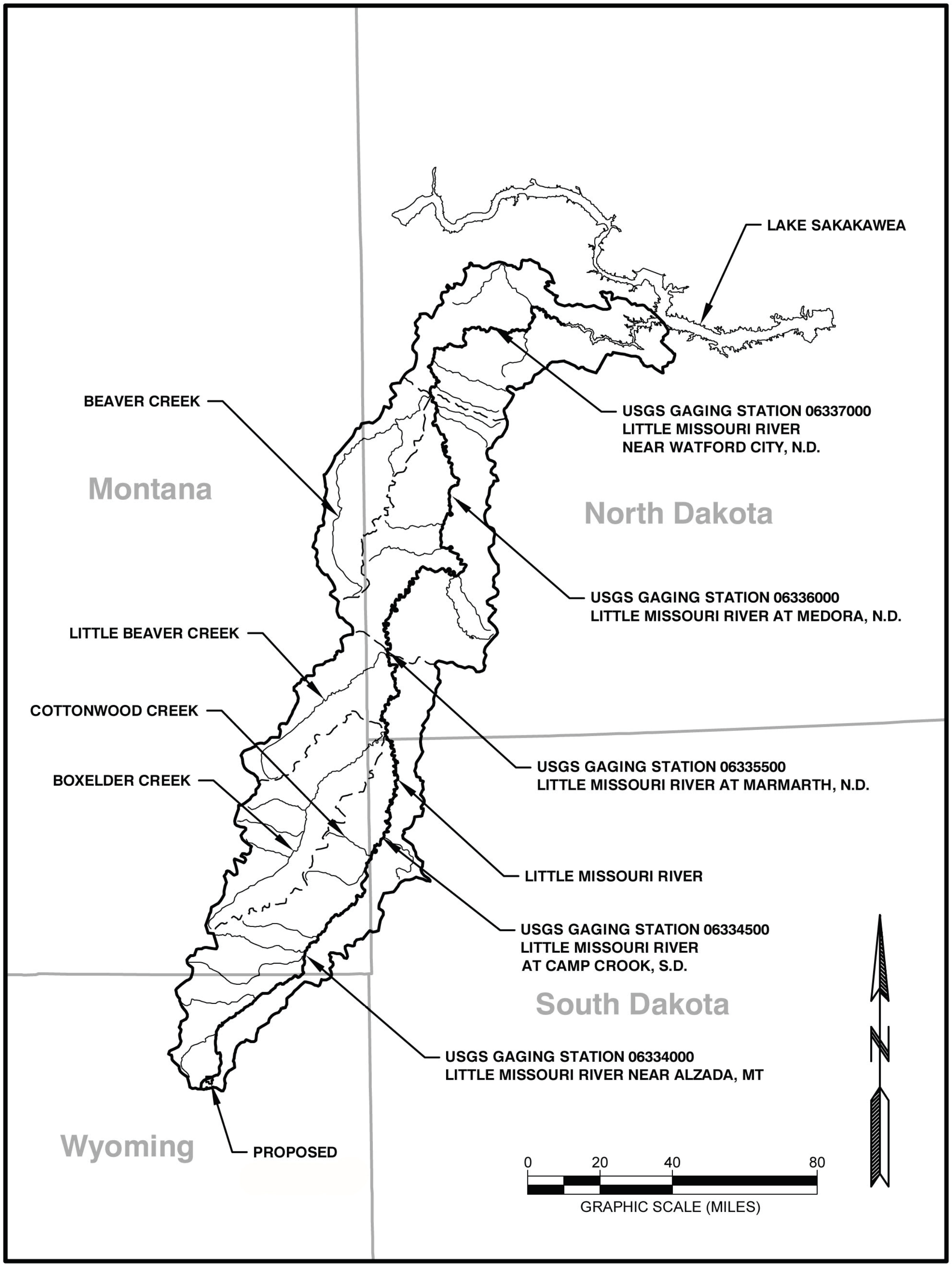
3.5.1 Surface Water

The Ross Project area is located in the upper reaches of the Little Missouri River Basin. The Little Missouri River originates in northeastern Wyoming, flows through southeastern Montana, through northwestern South Dakota, and into North Dakota where it empties into the Missouri River at Lake Sakakawea. The total river length is 652 km (405 mi), and the total drainage area (i.e., the area where all surface waters flow toward the Little Missouri River) is approximately 24,500 km^2 [9,470 mi^2]. Figure 3.10 depicts the Little Missouri River Basin. The drainage area of the Little Missouri River at the downstream boundary of the Ross Project area is approximately 47 km^2 [18.2 mi^2].

A surface-water monitoring system has been employed by the Applicant to characterize surface-water quantity and quality at the Ross Project area. This system includes three monitoring stations and was designed to monitor the major surface-water drainages to the Little Missouri River and to establish pre-licensing baseline, site-characterization surface-water quality.

Surface-Water Features

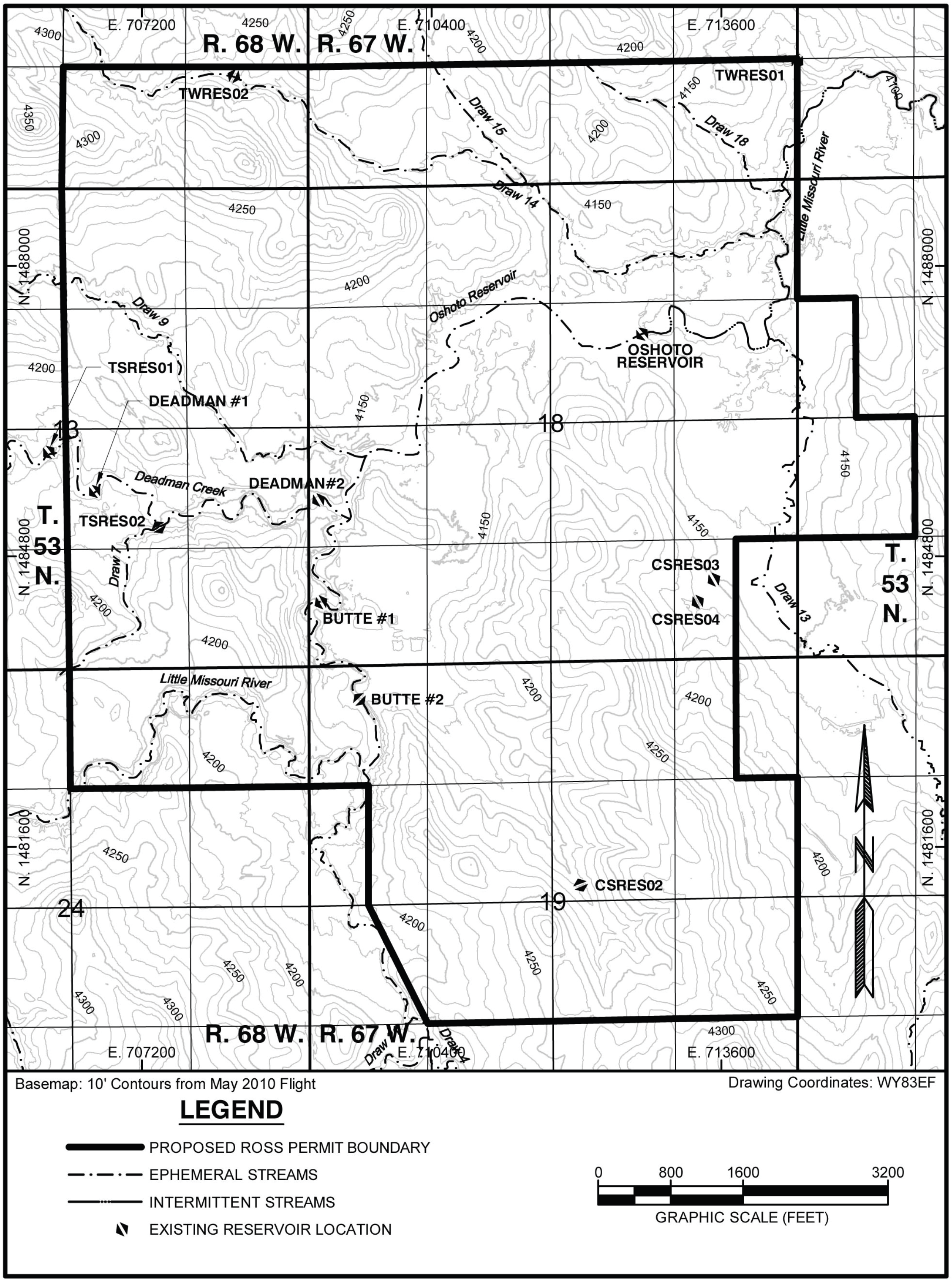
The surface-water features located within the Ross Project are depicted in Figure 3.11 and consist of several reservoirs and minor stream channels. Oshoto Reservoir, located in the channel of the Little Missouri River, is the main hydrologic feature of the Project area (Water



Source: Strata, 2012a.

Figure 3.10

Little Missouri River Basin and Surface-Water Gaging Stations



Source: Strata, 2012a.

Figure 3.11

Surface-Water Features of Ross Project Area

Right Permit No. P6046R) (WSEO, 2006). The only potential springs identified within the Ross Project area are associated with nearby wetlands (see Section 3.5.2 of this SEIS) or with the Little Missouri River in the vicinity of the Oshoto Reservoir.

The Applicant has identified 12 existing reservoirs within or just outside the Ross Project area using aerial photography, Wyoming State Engineer's Office (WSEO) permits, and landowner interviews (see Figure 3.11). Other than the Oshoto Reservoir, which has a maximum capacity of 21 ha-m [173 ac-ft] and an area of 11.3 ha [28 ac], all the identified reservoirs have a capacity of less than 1.2 ha-m [10 ac-ft] and a surface area of less than 1 ha [2.5 ac] (Strata, 2011a). The Oshoto Reservoir has the potential to affect stream flow and appears to influence water-table elevations in its proximity (Strata, 2011a).

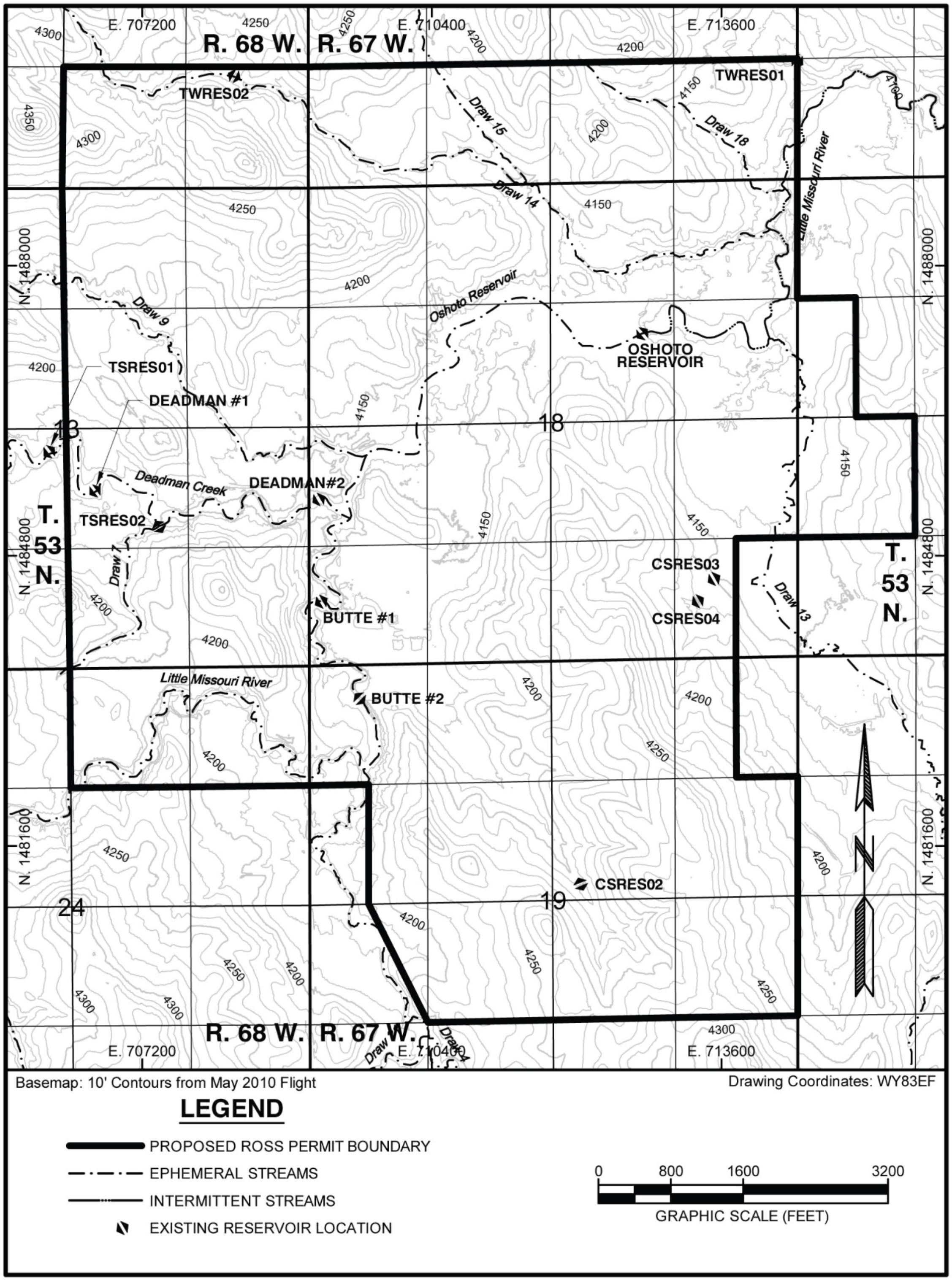
There are three Wyoming Pollution Discharge Elimination System (WYPDES)-permitted outfalls associated with the oil-production operations within the watershed that includes the Ross Project area: two upstream from the Ross Project (Permit Nos. WY0044296 and WY0033065) and one downstream (Permit No. WY0034592) (Strata, 2011a). Discharge rates from the outfalls are relatively low, approximately 0 – 150 m^3/d [0 – 5,300 ft^3/d].

Surface-Water Flow

As shown in Figure 3.10, five USGS gaging stations are located on the Little Missouri River downstream of the Ross Project (USGS, 2012a). The mean annual discharges range from 2 m^3/s [77 ft^3/s] at the most upstream gaging station (near Alzada, Montana) to 15.1 m^3/s [533 ft^3/s] at the most downstream gaging station (near Watford City, North Dakota). The discharges are typically lowest from November through January and highest during the months of March through June (Strata, 2011a). The peak flow for the Alzada, Montana, gaging station occurred in April 1944 when an estimated discharge of 170 m^3/s [6,000 ft^3/s] occurred. The peak flow at the Camp Crook, South Dakota, gaging station took place in March 1978 with a flow of 267 m^3/s [9,420 ft^3/s]. The timing of these events indicates that snow melt and spring runoff typically result in the highest flows for this portion of the Little Missouri River.

The Applicant has established three surface-water monitoring stations and installed continuous stage recorders and pump samplers at each station within the Ross Project area in 2010 (see Figure 3.12) (Strata, 2011a). The stations were located at two sites on the Little Missouri River and one site on Deadman Creek, a tributary to Little Missouri River. The stage recorders are designed to continuously measure discharge and are integrated with the pump samplers that collect water-quality samples during runoff events. The Applicant reports flow data from the three surface-water monitoring stations from June 15, 2010, to October 11, 2011, with a break during the respective winter when the monitoring stations were removed to prevent their freezing (Strata, 2012a).

The results of the surface-water monitoring indicate that, where the streams enter the Ross Project area (SW-2 and SW-3), flow is in response to only snow-melt or precipitation events (i.e., ephemeral) (Strata, 2011a). The Little Missouri River, downstream from the proposed Ross Project boundary (SW-1), has flow for an extended period of the year but not all of the



Source: Strata, 2012a.

Figure 3.12

Surface-Water Monitoring Stations at Ross Project Area

year and is, thus, intermittent. The Applicant compared the average daily flow observed at SW-1 to the water-surface elevation in Oshoto Reservoir (Strata, 2011a); the comparison suggests a correlation between the increased flow in the Little Missouri River downstream of Oshoto Reservoir and the amount of head in the Reservoir. This would indicate that some of the flow could be attributed to the stored capacity in Oshoto Reservoir.

What are the types of streams at the Ross Project area?

Perennial Streams: A perennial stream is a stream or part of a stream that flows continually during all of the calendar year as a result of ground-water discharge or surface runoff.

Intermittent Streams: An intermittent stream is a stream or part of a stream where the channel bottom is above the local water table for some part of the year, but which is not a perennial stream.

Ephemeral Streams: An ephemeral stream is a stream which flows only in direct response to a single precipitation event in the immediate watershed or in response to a single snow-melt event, and which has a channel bottom that is always above the prevailing water table.

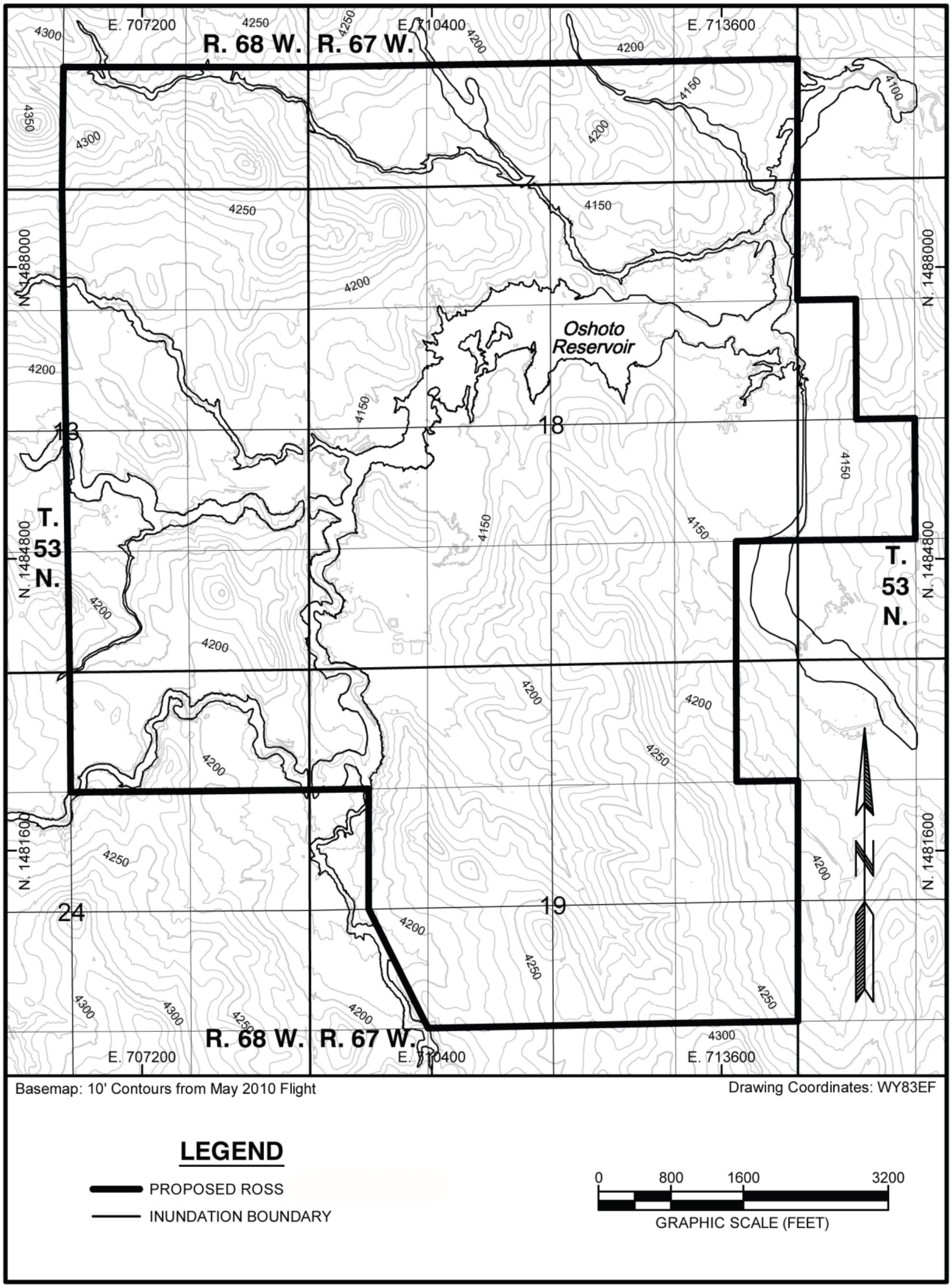
All streams within the Ross Project area, including the Little Missouri River and Deadman Creek, are classified by WDEQ/Water Quality Division (WQD) as 3B streams (WDEQ/WQD, 2001). A Class 3B stream is defined by the WDEQ/WQD as an intermittent or ephemeral stream with a designated use of "aquatic life other than fish." Uses such as drinking water and fisheries are excluded in a Class 3B stream. Approximately 64 km [40 mi] downstream of the Ross Project, the Little Missouri River becomes a class 2ABWW stream at its confluence with Government Canyon Creek; at this point, the River becomes protected as a drinking water source (2AB) and warm-water (WW) fishery.

There are no long-term stream-flow records for flows within or adjacent to the Ross Project; therefore, an U.S. Army Corps of Engineers' (USACE) Hydrologic Engineering Center (HEC)-hydrologic modeling system (HMS) model was developed by the Applicant to estimate the peaks and volumes of floods for various recurrence intervals (Strata, 2011a). The resulting inundation boundaries are shown on Figure 3.13. Measured peak flows during a 2-year, 24-hour storm event in May 2011 were less than predicted by the model, suggesting that the predicted model flows are conservatively high (Strata, 2012a).

Surface-Water Quality

Data from water-quality analyses of samples obtained from the Ross Project surface-water monitoring stations in 2009 and 2010 are provided in the Applicant's *Environmental Report* (ER) and *Technical Report* (TR) (see Figure 3.12) (Strata, 2011a; Strata, 2011b). Due to reasons ranging from the Applicant's not having a landowner's permission to no-flow conditions (i.e., there was no water flowing or the water was frozen), the number of quarters in which the monitoring stations were sampled ranges from one to six (Strata, 2011a). Water-quality analytical data from samples collected in 2011 were submitted to WDEQ/LQD and are provided in the Applicant's Responses to the RAIs issued by the NRC (Strata, 2012a). The data from 2011 are generally consistent with the 2009 and 2010 data, indicating a representative characterization of surface-water quality.

1



Source: Strata, 2012a.

Figure 3.13

Predicted 100-Year Flood Inundation Boundaries

The surface-water monitoring data characterizing the Little Missouri River and Deadman Creek from the first and second quarter of 2010 are summarized and described below. These data indicate that the overall water quality meets Wyoming's surface-water criteria for a Class 3B stream, which is the designation for the Little Missouri River.

- The water quality in all streams is generally consistent across the entire Ross Project area.
- The field pH measurements ranged from 7.6 – 8.9 standard units (s.u.), indicating alkaline water.
- The field measurements of dissolved oxygen ranged from 6.9 – 10.5 mg/L, indicating an intermediate to high level of oxygen in the water.
- Total salinity of the waters, expressed as total dissolved solids (TDS) concentrations, are low to moderate, ranging from 210 mg/L – 940 mg/L, and the water composition is dominated by sodium and bicarbonate.
- Iron and manganese concentrations in unfiltered samples ranged from 0.32 – 0.95 mg/L and 0.05 – 0.21 mg/L, respectively, suggesting the presence of suspended sediment in the samples.
- Dissolved metals were near or below detection limits, with the exception of iron and uranium. Iron concentrations ranged from less than 0.05 mg/L to 0.92 mg/L, with an outlier of 8.32 mg/L in the sample collected in the third quarter from Station R-5. Concentrations of dissolved uranium ranged from 0.003 – 0.02 mg/L.
- Dissolved radium-226 was less than the detection limit of 0.01 Bq/L [0.2 pCi/L]. Dissolved radium-228 was undetected (i.e., less than 0.04 Bq/L [1 pCi/L]) except for one sample obtained at Station SW2, where it was counted at 0.05 Bq/L [1.3 pCi/L].
- Gross alpha and gross beta ranged from 0.2 – 0.33 Bq/L [4 – 8.8 pCi/L) and 0. 2 – 0.41 Bq/L [6 – 11.2 pCi/L], respectively.

Other water-quality data suggest that the TDS increases downstream in the Little Missouri River and sulfate becomes the dominate anion (Langford, 1964).

The total anion/cation balances were calculated from the analyses of major ions as a quality-control check on the laboratory analyses. The balances, less than 3 percent in 31 of the 36 samples analyzed, and between 3 and 5 percent in five samples, validated the accuracy of the analyses (Strata, 2011a).

The Applicant attempted to collect water-quality samples from 11 reservoirs (see Figure 3.12) from the third quarter of 2009 through the third quarter of 2011 (i.e., quarterly) (Strata, 2011a; Strata, 2011b, Strata. 2012a). Samples were not collected when the reservoirs were dry or frozen or when the Applicant was not able to obtain the landowner's permission. These water-quality data indicate the following:

- Higher TDS corresponds to low-flow conditions in the fourth quarters of both years. TDS in samples of the reservoirs on the channels of the Little Missouri River and Deadman Creek, upstream from Oshoto Reservoir, ranged from 970 – 2,320 mg/L compared to a range of 460 – 730 mg/L in the Oshoto Reservoir and a range of 100 – 170 mg/L in the reservoir on the Little Missouri River downstream of the Oshoto Reservoir. The TDS in the reservoirs upland from the stream channels range from 110 – 1190 mg/L. Bicarbonate or carbonate (depending upon the pH) was the dominant anion in all of the waters. Sodium was the dominant cation, except in waters on the low end of the TDS range, where calcium was often the dominant cation.

- The waters in all reservoirs were alkaline, with field pH measurements generally ranging from 8 – 10 s.u.
- Field-measured dissolved oxygen ranged from 0.46 – 11.3 mg/L, suggesting seasonal low oxygen conditions.
- Similar to the streams, dissolved metals were generally at or near the laboratory detection limits, except for uranium and iron. Uranium ranged from less than 0.001 – 0.009 mg/L in all of the reservoirs except for those on Deadman Creek, where uranium concentration ranged from 0.019 – 0.087 mg/L. Detectable concentrations of dissolved iron generally corresponded to depleted dissolved oxygen levels. Measureable concentrations of total iron and manganese indicate the presence of sediment in the samples.
- The available data for radionuclides show that most of the analyses were less than the laboratory's lower limit of detection. However, detectable concentrations of lead-210, radium-226 (dissolved and suspended), dissolved radium-228, and suspended thorium-230 were detected. Gross alpha and gross beta ranged from less than 2 – 48.4 pCi/L and 3.9 – 48.5 pCi/L, respectively. The highest values of gross alpha and gross beta were measured in samples from reservoirs on Deadman Creek.

Surface-Water Uses

A search of the WSEO database of permitted surface-water rights within the Ross Project boundaries and the adjacent 3-km [2-mi] radius revealed that 43 surface-water rights existed within and adjacent to the Ross Project in 2010 (WSEO, 2006; Strata, 2011a). The search of the WSEO database indicated that nearly half of the water-right permits have been cancelled, while the remaining permits are complete, fully adjudicated, or un-adjudicated (Strata, 2011a). In addition to the permitted surface-water rights, there are at least 17 additional reservoirs within or adjacent to the Ross Project area, although none of these reservoirs was listed in the WSEO water-rights database, except for the Oshoto Reservoir (Strata, 2011a).

Surface water within the Ross Project area and surrounding 3-km [2-mi] vicinity is primarily used for livestock watering, with lesser amounts used for irrigation and industrial uses (primarily as a temporary water supply for oil- and gas-construction activities) (Strata, 2011a). Including reservoirs not listed in the WSEO database, stock reservoirs account for approximately 90 percent of the total active water rights (Strata, 2011a). Most of the stock reservoirs were constructed before 1970, and the majority are still in use today. Irrigation-water rights only account for a relatively small portion (less than 10 percent) of the surface-water rights. All of the irrigation rights were permitted 50 – 100 years ago for relatively small areas (28 ha [70 ac] or less). The one water right for Nubeth signifies the rise of uranium exploration in the late 1970s. Following this, there were some 15 temporary water-haul permits for oil- and gas-related activities from 1980 – 1991. Finally, the two most recent water rights were appropriated by the Applicant for exploration activities at the Ross Project area (Strata, 2011a).

3.5.2 Wetlands

The Federal definition of wetlands includes “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas” (33 CFR Part 328.3). Wetlands are important resources that provide habitat for aquatic fauna and flora, filter sediments and toxicants, and attenuate floodwaters.

Projects that discharge, dredge, or fill material into “Waters of the United States,” a concept related to surface- and ground-water regulation which includes special aquatic sites and wetlands under the jurisdiction of the USACE, require accurate identification of wetland boundaries for Section 404 of the *Clean Water Act*-permitting process. Through the Section 404 permitting process, the USACE can authorize dredge or fill activities by issuance of a standard individual permit, regional permit, or the Nationwide Permit (NWP).

Site-specific field surveys on behalf of the Applicant were conducted at the Ross Project by WWC Engineering (WWC) staff on June 22 and 28 as well as July 8 and 21, 2010. These surveys were in accordance with the “Interim Regional Supplement to the USACE Wetlands Delineation Manual: Great Plains Region” (USACE, 2008; Strata, 2011a). These wetlands surveys were conducted to identify and to characterize the wetlands located within the Ross Project area. Existing data used in the survey included Natural Resource Conservation Service (NRCS) soil mapping, U.S. Fish and Wildlife Service’s (USFWS’s) National Wetlands Inventory (NWI) mapping, and aerial photography taken May 2010 (NRCS, 2010; USFWS, 2012a; Strata, 2011a).

Thirteen wetland sites were identified on the NWI maps within the Ross Project area and were investigated during the 2010 field surveys. Potential wetlands identified during the initial June survey were later visited during another survey in July to verify that wetland characteristics were present. The wetlands-survey results, photographs, and correspondence with the USACE are provided in the Applicant’s ER (Strata, 2011a). All but two of the NWI areas were included in the baseline field-delineated wetlands (Strata, 2011a). The two sites not included did not have the three required characteristics for a wetland. The three criteria are: 1) hydrophytic vegetation (i.e., plants that grow in hydric soils), 2) hydric soil (i.e., soils that are commonly flooded or saturated), and 3) wetland hydrology (USACE, 2008).

Many of the potential wetland areas delineated during the 2010 field surveys were small depressions (<0.04 ha [0.1 ac]) that were in close proximity to each other but were distinct depressions separated by upland vegetation. A significant number of these small-depression areas appeared to be influenced by ground water, receiving seepage from the Lance Formation, which outcrops in the vicinity. These potential wetlands were classified according to Cowardin et al. (1979) to more accurately describe the types of potential wetlands present within the Ross Project area (Strata, 2011a). Approximately 93 percent of the potential wetlands were man-made (i.e., diked or excavated). A significant majority of these are preliminarily classified as Palustrine, Aquatic Bed, Seasonally Flooded (PABFh) or Diked. Of the areas designated as PABFh, approximately half were areas of open water. In addition, there were approximately 2.1 ha [5.1 ac] (6,750 linear m [22,130 linear ft] x an average 3-m- [10-ft]-wide channel) of “Other Waters of the U.S.” identified within the Ross Project area (Strata, 2011a).

A wetlands delineation report for the Ross Project was submitted to the USACE Omaha District in Cheyenne, Wyoming, during September 2010 (Strata, 2011a). The USACE provided the Applicant a letter on December 9, 2010, that verified the following (USACE, 2010):

- The methods used to identify wetlands and other surface waters were consistent with the USACE's *Wetland Delineation Manual* and its current supplements.
- Exhibit 1 in the wetlands delineation report, entitled *Wetlands and Other Waters of the US. Delineation for the Proposed Ross ISR Project Oshoto, Wyoming* (*Wetland Map*) (dated August 23, 2010), provided an accurate depiction of the boundaries of all wetlands and other waters within the Ross Project area.
- All of the wetlands and channeled waterways identified in the delineation report are connected or adjacent to the Little Missouri River, a navigable water, and are thus likely to be Waters of the U.S. as defined in 33 CFR Part 328.

USACE's final determination of specific wetland areas would not occur until the Applicant applies for coverage for specific construction activities, such as pipeline installation and access-road stream-channel crossings. At that time, the Applicant would be required to provide a site-specific mitigation plan for its disturbance of jurisdictional wetlands (i.e., those wetlands that are under the jurisdiction of the USACE).

3.5.3 Ground Water

Regional Ground-Water Resources

The Applicant presents a description of the regional hydrogeology based upon published literature in its license application (Strata, 2011a; Strata, 2011b). The site-specific hydrogeology of the Lance Formation and the associated stratigraphy underlying the Ross Project area is not described in the GEIS; thus, detailed information is included here. Water-bearing bedrock intervals in the eastern Powder River Basin range in age from Precambrian to Paleocene (see Figure 3.7). Regionally, recharge occurs in the outcrop areas, with ground water moving away from the outcrop into the Basin. Due to the geologic dip of the units, horizons that are accessible near the Black Hills uplift are deeply buried in the Basin's center about 125 km [75 mi] west from the Ross Project area (Hinaman, 2005).

Within the northeast corner of Wyoming there are a number of water-bearing intervals tapped by municipalities and industrial users (Strata, 2011a; Langford, 1964). Below the Fox Hills aquifers, the Minnelusa Formation (210 – 270 m [700 – 900 ft] thick), and the underlying Madison Formation (90 – 270 m [300 – 900 ft] thick) are the most significant aquifers (Whitcomb and Morris, 1964). The Minnelusa and Madison aquifers are recharged at the outcrop in the area of the Black Hills uplift. Ground-water flow in all aquifers is from the recharge areas along the outcrop, westward towards the center of the Powder River Basin. Flow directions are locally modified by pumping wells. The Minnelusa Formation has received aquifer exemptions in portions of Campbell County, which allow it to be used for waste-water disposal (EPA, 1997).

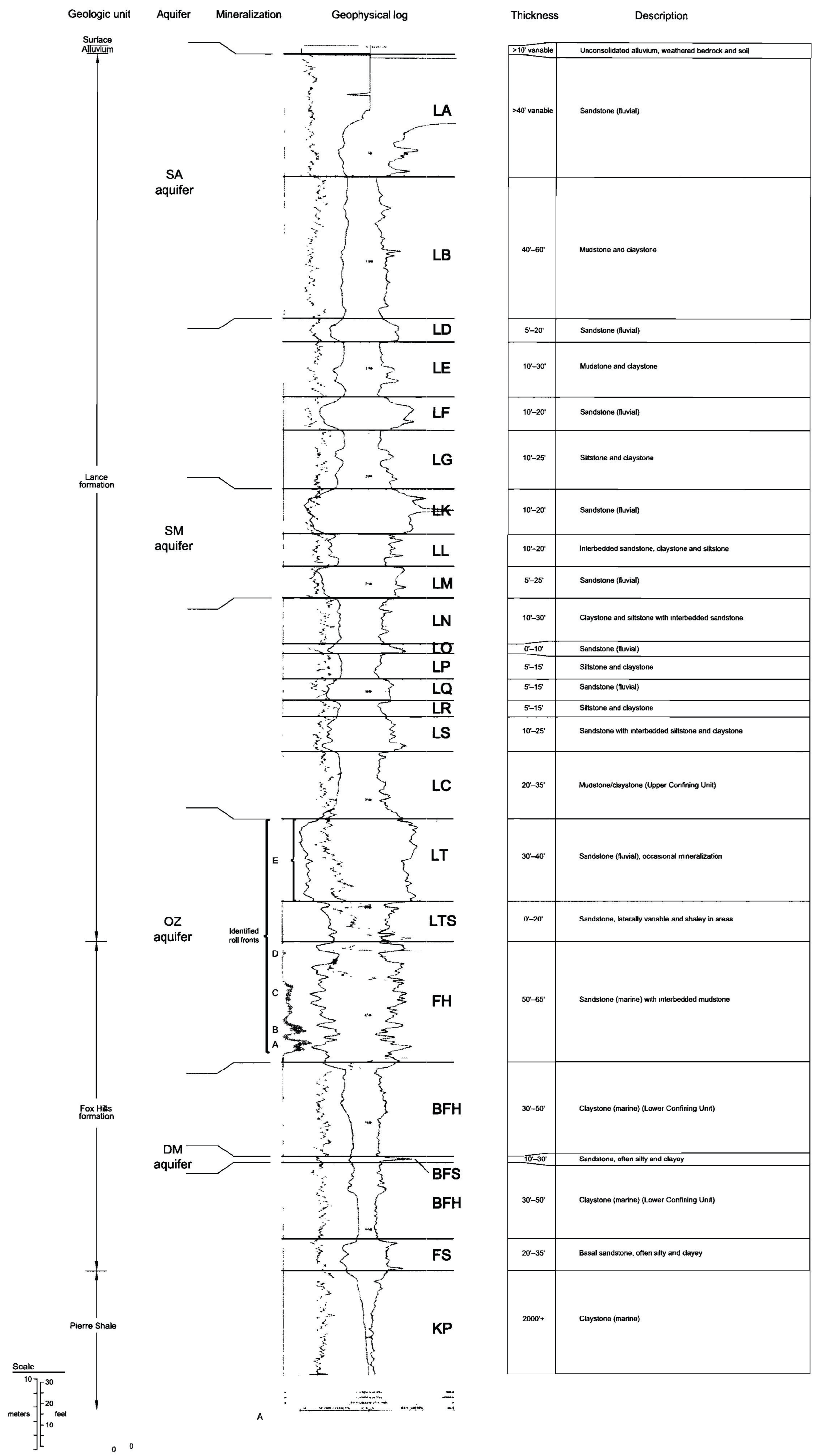
The Minnelusa Formation is also an important hydrocarbon reservoir interval in the areas of the Powder River Basin that are west of the Ross Project (De Bruin, 2007). At the Ross Project area, the Minnelusa Formation is approximately 1,860 m [6,100 ft] bgs (Strata, 2011a). It is separated from the ore zone by 1,680 m [5,500 ft] of sandstone, claystone and shale, most notably the Pierre Shale which is over 600 m [2,000 ft] thick under the Ross Project area as noted in SEIS Section 3.4 (Whitcomb and Morris, 1964).

Water-supply wells in the Madison Formation have reported yields of up to 3,785 L/min [1,000 gal/min]; the Formation is an important source of drinking water for the communities of Gillette and Moorcroft. The city of Gillette operates a wellfield consisting of ten wells north of the town of Moorcroft, yielding 35,204 L/s [9,300 gal/s] from a depth of approximately 760 m [2,500 ft]. The water is piped approximately 53 km [33 mi] to Gillette and blended with locally-produced ground water from the Fort Union Formation and to a lesser degree from wells completed in the Lance and Fox Hills Formations. Other towns in the vicinity (e.g., Moorcroft, Sundance, Upton, Newcastle, and Hulett) also use the Madison Formation for municipal water supply (Strata, 2011a). In the vicinity of Gillette, the Fox Hills and Lance Formations are typically targeted by industrial users, while smaller municipalities, subdivisions, and improvement districts west of Ross Project area use wells completed within the shallower Fort Union Formation.

Local Ground-Water Resources

The detailed geologic stratigraphy and its relationship to the corresponding hydrology are illustrated in Figure 3.14. The detailed stratigraphic sequence from the land surface to the confining interval below the ore zone is, in descending order: recent, unconsolidated, surficial deposits including residual soils, colluvium, and alluvium; Lance Formation; Fox Hills Formation; and Pierre Shale (see also SEIS Section 3.4). Figure 3.14 illustrates the geophysical log and corresponding lithology obtained from type exploration drillhole No. RMR008, the location of which is shown in Figure 3.14. This particular drillhole was chosen as the “type log” by the Applicant for the Ross Project because of the clarity of the geophysical logs and the associated stratigraphic descriptions from land surface to the top of the Pierre Shale (Strata, 2011a).

Within the Ross Project there are four named aquifers existing between the land surface and the Pierre Shale. The correspondence between stratigraphic and hydrologic units, and the related nomenclature, is summarized in Table 3.4.



Source: Strata, 2012a.

Figure 3.14

Stratigraphic and Hydrogeologic Units at Ross Project Area

Table 3.4
Geologic Units, Stratigraphic Horizons, and Hydrologic Units of Ross Project Area

Geologic Unit	Stratigraphic Horizon	Hydrologic Unit
Lance Formation and/or Recent Alluvium/Colluvium	Qal/LA/LB	SA (Surface Aquifer)
Lance Formation	LD-LG	Lance Units (Aquitard)
	LK-LM	SM (Shallow-Monitoring Aquifer)
	LN-LS	Sandstone within Confining Unit
	LC	Upper Confining Unit
	LT-LTS	OZ (Ore-Zone Aquifer)
Fox Hills Formation	FH	
	BFH	Lower Confining Unit (Aquitard)
	BFS	DM (Deep-Monitoring Aquifer)
	BFH/FS	Sandstone within Confining Unit
Pierre Shale	KP	Regional Confining Unit (Aquitard)

Source: Strata, 2012b.

The surficial aquifer, or the SA interval, is the “water-table” aquifer within the Ross Project area. It consists of the uppermost water-bearing interval within the upper Lance Formation and the alluvium of the Little Missouri River and Deadman Creek. Ground-water levels range from near-surface in the river valleys to over 15 m [50 ft] bgs in topographically higher areas.

The sandstones of the lower Lance Formation (LT intervals) make up the upper portion of the ore zone (i.e., ore-zone [OZ] aquifer) (see Figure 3.14). The LT sands range in thickness from 9 – 12 m [30 – 40 ft] and show hydraulic continuity beneath the Ross Project area. Above the LT sands is a shale layer varying in thickness from 6 – 24 m [20 ft – 80 ft], locally called the LC interval aquitard. The Applicant designates the LC aquitard as the “upper confining unit.” The LC aquitard serves as a confining unit that separates the uranium-mineralized sandstones of the FH and LT horizons and the OZ aquifer, from the water-bearing unit above (see Figure 3.14).

The water-bearing sands above the upper confining unit is referred to as the shallow-monitoring (SM) unit, or SM aquifer, and is composed of the LM- through LK-horizon sandstones. Above the SM aquifer is a sequence of thin sands, shales, and silts. Many of the thin sandstones contain water; however, these sandstones are generally discontinuous and, while they may be used locally for stock and domestic wells, they are not regionally extensive.

The Lance Formation is recharged at the outcrop and at the subcrop beneath the alluvium in the valley of the Little Missouri River and its tributaries. Natural ground-water flow would be expected to be westward from the outcrop toward the Basin.

At the Ross Project area, the thickness of the Fox Hills Formation is approximately 46 m [150 ft], with local variations of up to15 m [50 ft] or more. The Fox Hills Formation consists of an upper sandstone unit (i.e., FH horizon) and a lower sandstone unit (i.e., FS horizon) which are separated by an intervening shale, claystone, and mudstone interval (i.e., BFH horizon) containing the BFS sandstone unit (see Figure 3.14). Uranium mineralization primarily occurs within the Fox Hills Formation's sands, although in localized areas mineralization occurs within the overlying Lance Formation's (i.e., LT horizon) sandstone.

The FS and BFS sandstones represent the only water-bearing units within the lower Fox Hills Formation (see Table 3.4). Both sand units are believed to be continuous throughout the Ross Project area, although in places they are relatively thin. The BFS horizon is the nearest aquifer below the uranium-bearing sandstone (the FH horizon and also known as the ore zone) in the upper Fox Hills Formation, and in terms of uranium-recovery operations, it is referred to as the deep-monitoring (DM) interval, or the DM aquifer. It is separated from the FH sand (i.e., the ore zone) above and the FS (basal sandstone) below by a shale, claystone, and mudstone (BFH horizon). The Applicant provides potentiometric contours for the DM interval in its ER (see Figure 3.15) (Strata, 2011a).

The Pierre Shale yields very little water; it is considered regionally as a confining unit (NRC, 2009b; Whitehead, 1996). No wells are known to be completed within the Pierre Shale at the Ross Project area.

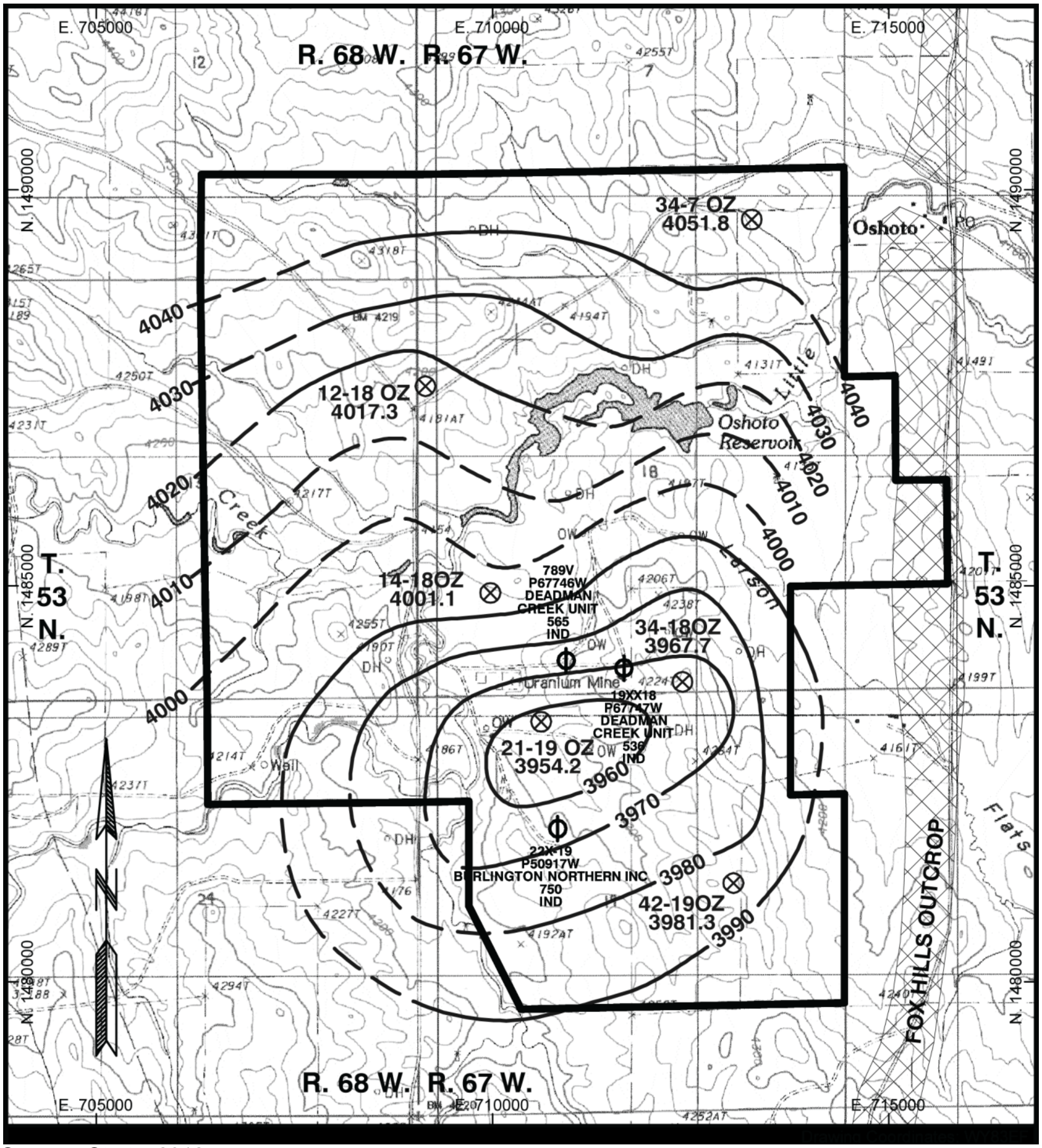
The FH horizon sandstones within the upper Fox Hills Formation contain uranium and are the primary uranium-recovery target interval for the Proposed Action. The Applicant has designated the OZ aquifer as consisting of the FH sandstones with the overlying lower Lance Formation sandstones (LT horizon). The lithologies of the ore zone range from thick-bedded, blocky sandstones to thin, interbedded sandstones, siltstones, and shales. The OZ aquifer is underlain by claystone of the Fox Hill Formation (i.e., BFH interval). Within the Ross Project area, this ore-zone interval ranges from 27 – 55 m [90 – 180 ft] thick (see Figure 3.14). Thin, silty, and clayey sandstone comprises the DM aquifer. The Applicant designates the BFH aquitard above the DM aquifer and below the ore zone as the "lower confining unit."

What terms are used to describe hydrologic characteristics?

Transmissivity: This term is used to define the flow rate of water through a vertical section of an aquifer, considering a unit width and extending the full saturated height of the aquifer under unit hydraulic gradient. Transmissivity is a function of an aquifer's saturated thickness and hydraulic conductivity.

Hydraulic Conductivity: This term represents a measure of the capacity of a porous medium to transmit water. It is used to define the flow rate per unit cross-sectional area of an aquifer under unit hydraulic gradient.

Storativity: This term is used to characterize the capacity of an aquifer to release ground water from storage in response to a decline in water levels.



Source: Strata, 2012a.

Figure 3.15

Potentiometric Contours of Ground Water in Ore-Zone Aquifer

1

Isopachs of this structure show that it ranges in thickness from less than 3 m [10 ft] to more than 30 m [100 ft] (Strata, 2011a). Above the ore zone, the mudstone and claystone of the Lance Formation form the upper confining unit, as noted above, ranging in thickness from less than 6 m [20 ft] to more than 24 m [80 ft] (see Figure 3.14).

The FH sandstones, shales, and silts have been studied extensively through both core analysis and aquifer tests. Seven pumping tests targeting the ore zone were performed by the Applicant at six separate well clusters. Applicable methodology and testing were used and those results are shown in Table 3.5 (and additional details can be found in Strata, 2011a).

Table 3.5
Ore-Zone Aquifer Hydrogeologic Characteristics

	Transmissivity m^2/day [ft^2/day]	Hydraulic Conductivity cm/s [ft/day]	Storativity (Unitless)
Minimum	0.353 [3.80]	4.59E-05 [0.13]	4.00E-06
Maximum	34.2 [368]	2.69E-03 [7.62]	1.50E-04
Median	8.20 [88.3]	1.25E-03 [3.55]	6.10E-05
Geometric Mean	6.10 [65.6]	6.74E-04 [1.91]	4.50E-05
Average	8.15 [87.8]	1.15E-03 [3.26]	6.70E-05

Source: Addendum 2.7-F, Table 3, in Strata, 2011a.

The aquifer properties determined by the 2010 tests are comparable to results reported for previous pumping tests within the Ross Project area (Strata, 2011b).

The Applicant developed a static piezometric surface (i.e., a map showing the static water levels expressed as feet above sea level) for the ore-zone aquifer (see Figure 3.15). The ore zone’s potentiometric surface shows a distinct cone of depression near the No. 21-19 well cluster that has resulted from 30 years of ground-water withdrawals by oil-field water-supply wells completed in the OZ aquifer. This pumping has changed the hydraulic gradient and the direction of ground-water flow throughout most of the Ross Project area. The potentiometric surface near the No. 34-7 well cluster, which is farthest from the oil-field water-supply wells that have been pumping for 30 years, has been least affected by such pumping. Based upon the Applicant’s estimates, approximately 46 m [150 ft] of drawdown (i.e., the decline in water level) in the ore-zone aquifer has occurred in the vicinity of the No. 21-19 well cluster since pumping began in 1980 for local oil-field water-flood operations (Strata, 2011b). An updated map of the ore zone’s piezometric surface prepared by the Applicant using a ground-water model provides additional detail of the drawdown associated with the withdrawals from the Merit Oil Company’s (Merit’s) three water supply wells (Strata, 2012b).

The Applicant also calculated horizontal gradients and vertical-head differences between the OZ, SM, and DM aquifers (Strata, 2011a). Horizontal gradients in the OZ aquifer are toward the oil-field water-supply wells, and they range from 0.009 – 0.025, with the steeper gradients being in the vicinity of the oil-field water-supply wells. Vertical-head differences between the OZ and the DM aquifers range from 6 m [20 ft] downwards in the northwestern portion of the Ross Project area to 3 m [10 ft] upwards in the area of the oil-field water-supply wells. Vertical gradients are downwards from the SM to the OZ aquifers, with head differences ranging from 15 – 46 m [50 – 150 ft].

The OZ aquifer remains a confined aquifer across the Ross Project area, with potentiometric heads ranging from approximately 46 m [150 ft] to more than 122 m [400 ft] above the top of the ore zone (Strata, 2011a). Recharge to the Fox Hills Formation and, hence, the OZ aquifer, is from precipitation along the outcrop, ground water from the subcrop beneath alluvium in the valley of the Little Missouri River and its tributaries, and from leakage from the overlying Lance Formation. Under current conditions, discharge is to the oil-field water-supply wells.

Continuous measurement of water levels for the period April to October 2010 were recorded by the Applicant in six monitoring wells completed in the OZ aquifer and are presented graphically by the Applicant in its TR (Strata, 2011b). The hydrograph for Well 34-7OZ, which is located farthest from the oil-field water-supply wells, displays the least variation. The variability in the ore-zone-well hydrographs is a function of the well locations relative to the oil-field water-supply wells in Sections 18 and 19. The wells located closest to this area (Wells 21-19OZ, 34-18OZ, 14-18OZ, and 42-19OZ) display water-level fluctuations that are related to pumping of the water-supply wells. Pumping starts and stops that occurred in late June though early July 2010 are apparent on hydrographs from these wells. A rapid water-level rise (over 4.6 m [15 ft] in Well 21-19OZ) in late September 2010 was attributed to a temporary cessation of pumping. This was followed by a rapid decline in the water level, which was interpreted as an indication of resumption of pumping.

Other than the aquifer testing that took place over the period above, other recorded perturbations are related to sampling events and barometric fluctuations. The barometric fluctuations are less than 0.2 m [0.5 ft]. During January through October 2010, the hydrograph for Well 34-7OZ showed a steady increase of approximately 0.6 m [2 ft]. The cause of this increase has not been identified; similar patterns have not been seen in other ore-zone well hydrographs. The hydrograph for Well 12-18OZ varies within a range of approximately 0.76 m [2.5 ft]. Most of the water-level changes are interpreted as responses to barometric pressure changes. However, fluctuations in the late June though early July time period coincide with pumping-related water-level changes observed in the group of four wells discussed above.

The shale, claystone, and mudstone interval, the BFH horizon and lower confining unit, separates the DM aquifer from the FH horizon. This low-permeability unit ranges in thickness from less than 3 m [10 ft] to 24 m [80 ft]. Vertical hydraulic conductivities for this interval are expected to be comparable to that of the Pierre Shale (i.e., 2×10^{-7} cm/s [5×10^{-4} ft/day] or less), based on their similar lithologies.

Pumping tests were performed on six well clusters with pumping from the OZ aquifer and monitoring of the SA, SM, and DM aquifers. No effects from pumping were measured in any of the overlying SA or SM wells. Water levels in two of the six underlying DM wells (Nos. 14-18DM and 34-18DM) declined slightly during pumping. The lower confining unit is 9 – 15 m [30 ft – 50 ft] thick in the portions of the Ross Project area where these wells are located. The response of the DM-completed wells has been interpreted by the Applicant as being due to vertical leakage across the lower confining unit via drillholes that are in close proximity to the pumping-test well cluster that have not yet been located and plugged. Prior to the Applicant's conducting the aquifer test at Well 12-18, all exploration drillholes in the vicinity of that well cluster were located and plugged, and no response of the DM-aquifer well was observed during that pumping test.

Communication between the OZ and DM aquifers in locations where the lower confining unit has been breached was demonstrated by: 1) the responses observed in the DM zone for two pumping tests, where old exploration drillholes had not been plugged and 2) the similarities in the potentiometric heads in the DM, OZ and SM aquifers in the vicinity of the oil-field water-supply wells, which are completed in both the OZ and DM intervals. To prevent communication between aquifers during uranium-recovery operation, the Applicant proposes to actively locate and plug all exploration drillholes prior to beginning wellfield operations. The Applicant proposes to actively locate and plug all exploration wells prior to beginning wellfield operation.

Ground-Water Quality

The Applicant has compiled regional water-quality data listed in the USGS's NWIS from 16 wells located in Crook and Campbell Counties that were completed in the Lance and Fox Hills aquifers (Strata, 2011a; USGS, 2012b). Data from these wells show a water quality of the Lance and Fox Hills aquifers that is slightly alkaline (i.e., median pH of 8.4) with a median TDS of 1,130 mg/L, with sodium and bicarbonate as the dominant dissolved species.

The water quality of shallow ground water from alluvial deposits on the Lance Formation is dominated by sodium, sulfate, and bicarbonate with moderate levels of TDS of approximately 1,200 – 1,400 mg/L (Langford, 1964). Rankl and Lowry (1990) noted that the water quality in the aquifer sequence through the Lance and Fox Hills Formations depends upon the stratigraphy and varies according to well depth. As well depths increase from 30.5 – 152 m [100 – 500 ft], TDS in the waters decrease sharply due to declining concentrations of calcium, magnesium, and sulfate. Water from wells at depths of 152 m [500 ft] or greater are dominated by bicarbonate and sodium.

The deep-injection-well UIC Class I permit application for the Ross Project contains estimates of water quality in deeper formations, from the Minnelusa through the Cambrian Formations (WDEQ/WQD, 2011). The Minnelusa, Deadwood, and Flathead Formations are expected to have TDS concentrations greater than 10,000 mg/L, while the Madison Formation likely has a TDS concentration around 1,000 mg/L in the vicinity of the Ross Project area.

To comply with the requirements of 10 CFR Part 40, Appendix A, Criterion 7, the Applicant has collected pre-licensing baseline ground-water-quality data from the site characterization of the Ross Project area. These data originate from three sources: 1) the Applicant's own baseline site-characterization monitoring network at the Ross Project and the respective analytical data; 2) existing water-supply-wells sampling and analysis data; and 3) historical data from the former Nubeth operation (Nuclear Dynamics, 1978). The first source of ground-water quality data is the Applicant's own ground-water-monitoring network which it constructed in 2009 and 2012 and which consists of six monitoring-well clusters and four piezometers (Strata, 2011a). Each well cluster includes four monitoring wells targeting the OZ aquifer and the aquifer units above the ore zone (SA and SM) and below the ore zone (DM) (see Figure 3.14). The Applicant provided construction details of the wells and methods used for ground-water sampling in its ER (Strata, 2011a). The four piezometers in the SA were installed in the portion of the Ross Project area proposed for the central processing plant (CPP) and surface impoundments (Strata, 2011a).

Analytical data from the 2010 quarterly samples are provided in the Applicant's ER and TR (Strata, 2011a; Strata, 2011b). Water-quality data from samples collected in 2011 and submitted to WDEQ/LQD are provided in information received subsequently from the Applicant (Strata, 2012a). The data from 2011 are generally consistent with the 2009 and 2010 data, indicating a representative characterization of ground-water quality. The data are summarized in the following paragraphs.

The average concentrations of the major cations and anions, in addition to the median field measurements of pH and average dissolved-oxygen measurements, are presented on the next page in Table 3.6. Dissolved solids (TDS) in the ground water at the Ross Project area are predominately bicarbonate-sulfate-sodium, which differs from typical ground water described in the GEIS, which is the bicarbonate-sulfate-calcium type. The pH conditions of greater than 8.5 are consistent with bicarbonate water, and dissolved oxygen levels of less than 5 mg/L suggest low-oxygen conditions. These two parameters are typical of uranium-bearing aquifers (NRC, 2009b).

The water quality data indicates distinctive water quality in each aquifer unit, i.e., the SA, SM, OZ, and DM. The distinctive water quality is made possible by the stratigraphic layers between the aquifer units that prevent vertical movement of water between the units. Average values of TDS in Strata's ground-water baseline monitoring network range from 730 mg/L in the SA to 1574 mg/L in the OZ. Ground-water from piezometers in the SA show that the TDS increases sharply with increasing distance from the Little Missouri River (Strata, 2011a).

The effects on Strata's pre-licensing baseline water quality from Nubeth can be evaluated by comparing the Strata's data with baseline data reported by Nuclear Dynamics (1978). The data from Strata (2011a, 2012a) include all four aquifer units. Nuclear Dynamics (1978) reports data from only the ore zone and the aquifer above the ore zone which is likely equivalent to the SM. The comparison shows that the TDS in the SM and OZ have decreased since 1978 (see also SEIS Section 5.7.2).

Table 3.7 summarizes the concentrations of metals, radiological parameters, ammonium, and fluoride measured by Strata in the aquifer units. With a few exceptions, the 1978 mean values are within the range of values reported by Strata (2011a, Strata, 2012a). Strata's pre-licensing baseline concentrations of arsenic, radium-226, and gross beta are slightly lower in the ore zone than was measured in 1978 (Table 3.7). Strata's concentrations of cadmium, lead and nickel are slightly lower in both the ore zone and the aquifer above the ore zone than in 1978.

Table 3.6 Average Concentrations of Major Cations and Anions in Ground Water from the Ore-Zone (OZ) Aquifer and Aquifers Above (SM & SA) and Below (DM) the Ore Zone[†]							
		Ross Project Monitoring-Well Data (Strata, 2011a; Strata, 2012a)				Nubeth Data (Nuclear Dynamics, 1978)	
Constituent	Units	Surficial Aquifer (SA)	Shallow-Monitoring Aquifer (SM)	Ore-Zone Aquifer (OZ)	Deep-Monitoring Aquifer (DM)	Ore Zone	Above Ore Zone
Bicarbonate	mg/L	339	449	583	295	592	653
Calcium	mg/L	21	2	6	3	6.2	6
Carbonate	mg/L	N/A	98	26	103	22	17
Chloride	mg/L	29	4	7	491	10	6
Magnesium	mg/L	13	<1**	2	<1**	2.7	2.7
Potassium	mg/L	12	15	6	19	3.2	3.9
Sodium	mg/L	224	417	545	520	622	592
Sulfate	mg/L	172	318	602	31	715	567
Total Dissolved Solids (TDS)	mg/L	730	1145	1574	1321	1629	1498
Dissolved Oxygen (DO)	mg/L	3.2	3.9	2.8	4.7	N/A***	N/A***
pH	Std. Units	8.6	9.15	8.7	9.4	8.8	8.6

Source: Strata, 2011a; Strata, 2012a; Nuclear Dynamics, 1978.

Notes:

† All values are mean concentrations, except for pH from Strata data, which is the median value, and pH reported in Nubeth, which is a mean value.

† Shading indicates a value greater than WDEQ and U.S. Environmental Protection Agency (EPA) Water Quality Standards.

***** 34 percent of the 32 reported concentrations were below the detection limit, which precluded calculation of an average or median value; minimum and maximum values for carbonate concentration in mg/L were less than 5 and 218 mg/L, respectively, for this dataset.

******"<" = "Less than," where the value following the "<" is the detection limit.

***N/A = Not available.

Table 3.7
Summary of Water Quality of Ground Water from the Ore-Zone (OZ) Aquifer and Aquifers Above (SA & SM) and Below (DM) the Ore Zone†
2009, 2010, and 2011 Data from Ross Project Monitoring Wells Nos. 12-18, 14-18, 21-19, 34-7, 34-18, and 42-19 (As reported in Strata, 2011a; Strata, 2012a.)

		Ross Project Monitoring-Well Data								Nubeth Data	
		SA		SM		OZ		DM		Ore Zone	Above Ore Zone
Constituent*	Units	Min	Max	Min	Max	Min	Max	Min	Max	Mean	Mean
Ammonia	mg/L	<0.1**	0.6	<0.1	2.8	<0.1	0.8	<0.1	3.9	0.73	0.53
Arsenic	mg/L	<0.005	<0.005	<0.005	0.023	<0.005	<0.005	<0.005	0.014	0.11	<0.005
Barium	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.01	<0.10
Boron	mg/L	<0.1	0.3	0.2	0.8	0.3	0.6	0.3	1	0.32	0.6
Cadmium	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	0.004
Chromium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/L	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Fluoride	mg/L	0.1	0.8	0.8	2.1	0.2	1.3	0.8	1.6	N/A**	N/A
Iron	mg/L	<0.05	0.66	<0.05	0.21	<0.05	0.69	<0.05	0.4	0.09	0.074
Lead	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	0.037
Mercury	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.00004	0.00003
Manganese	mg/L	<0.02	0.36	<0.02	0.88	<0.02	0.06	<0.02	0.37	0.012	0.014
Molybdenum	mg/L	<0.02	0.07	<0.02	0.05	<0.02	<0.02	<0.02	0.06	<0.003	<0.005
Nickel	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.017	0.016
Selenium	mg/L	<0.005	0.008	<0.005	0.017	<0.005	0.009	<0.005	0.03	0.003	<0.005
Silver	mg/L	<0.003	0.006	<0.003	0.011	<0.003	<0.003	<0.003	0.005	<0.003	<0.003
Uranium	mg/L	<0.001	0.007	<0.001	0.004	0.005	0.109	<0.001	0.003	0.073	0.004
Vanadium	mg/L	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.003	<0.003
Zinc	mg/L	<0.01	1.32	<0.01	0.03	<0.01	0.02	<0.01	0.09	0.011	0.016
Radium-226	pCi/L	<0.2	0.5	<0.2	3.7	0.6	12.1	<0.2	0.7	22	0.06
Radium-228	pCi/L	<1	1.8	<1	12.27	<1	1.6	<1	2.2	N/A	N/A
Gross Alpha	pCi/L	<6	13.8	<7	12.2	<5	222	<14	28.3	98	1.4
Gross Beta	pCi/L	<8	17.6	<8	319***	<8	46.8	<20	41	97	3.2

Source: Strata, 2011a; Strata, 2012a; Nuclear Dynamics, 1978.
Notes on next page.

Notes for Table 3.7:

† Analytical results are presented as minimum and maximum values for each constituent; the number of measurements that are less than the detection level precludes calculation of mean concentrations.

† Shading indicates a value greater than WDEQ and EPA Water Quality Standards.

*All constituents reported as dissolved concentrations (i.e., the samples were filtered), except ammonia and fluoride.

** "<" = "Less than," where the value following the "<" value is the detection limit.
"N/A" = Datum not available.

***319 appears to be an anomalous value; the next lowest value is 42.5.

The similarity between the pre-licensing baseline concentrations in the ore zone and aquifer above the ore zone suggests that Nubeth did not alter the baseline water quality. Table 3.8 presents the WDEQ and EPA water-quality standards for constituents that were present in Strata's that were found to exceed the standards in Strata's pre-licensing baseline data (WDEQ/WQD, 2005b; 40 CFR Part 41). Concentrations of constituents that exceed the standards are indicated by shading in Tables 3.6 and Table 3.7.

Table 3.8
Water-Quality Standards Exceeded in Ground Water at the Ross Project (Pre-Licensing Baseline)

Water-Quality Constituent	Units	WDEQ Class I Domestic	WDEQ Class II Agriculture	EPA Primary MCL	EPA Secondary MCL
Ammonia	mg/L	0.5	N/A*	N/A	N/A
Arsenic	mg/L	0.05	0.1	0.01	N/A
Boron	mg/L	0.75	0.75	N/A	N/A
Chloride	mg/L	250	100	N/A	250
Iron	mg/L	0.3	5	N/A	0.3
Manganese	mg/L	0.05	0.2	N/A	0.05
Selenium	mg/L	0.05	0.02	0.05	N/A
Sulfate	mg/L	250	200	N/A	250
Total Dissolved Solids (TDS)	mg/L	500	2000	N/A	500
Uranium	mg/L	N/A	N/A	0.03	N/A
Radium-226 + 228	pCi/L	5	5	5	N/A
Gross Alpha	pCi/L	15	15	15	N/A

Source: WDEQ/WQD, 2005b.
Notes:
* N/A = Not applicable.
Per the WDEQ/LQD Hydrology Guideline No. 8 and NRC Regulatory Guide 4.14, the water-quality data produced by the Applicant and used to compare with the water-quality standards are dissolved concentrations except for ammonium, chloride, fluoride, sulfate, and TDS (WDEQ/LQD, 2005b; NRC, 1980).

Typical of uranium-bearing aquifers described in the GEIS (NRC, 2009b), the average TDS of each aquifer unit associated with Ross Project area exceed EPA's respective Secondary drinking water maximum contaminant levels (MCLs) of 500 mg/L, but they are within all the upper limits set by WDEQ for Class II Agriculture and Livestock Classes of Use (see Tables 3.6 and 3.8) (WDEQ/WQD, 2005b). The two upper aquifers, SA and SM, contain lower TDS than the lower units, and the OZ aquifer contains the highest average TDS.

Comparison of the metals, radiological parameters, ammonium, and fluoride to EPA's MCLs for drinking water and WDEQ standards are provided in Tables 3.7 and 3.8. Ammonia was measured in all four aquifer units at concentrations greater than WDEQ's standard for domestic use, 0.5 mg/L. Iron and manganese are present in all four aquifer units in concentrations greater than WDEQ's standard for domestic use and EPA's secondary MCL for drinking water. Arsenic was measured at concentrations greater than EPA's primary drinking water standard in the SM and DM but less than WDEQ's standard for domestic use. Boron was present at concentrations greater than the WDEQ standard for domestic use in the SM and DM. Uranium and radium-226 were present in the OZ at concentrations greater than the standards (see Table 3.8). Gross alpha exceeded the standards in the OZ and DM aquifer units.

As part of its ground-water sampling and analysis efforts, the Applicant identified 29 currently operable water-supply wells within the Ross Project area and the surrounding 2-km (1.2-mi) area (Strata, 2011a). These wells included two industrial wells, 12 domestic wells, and 15 stock wells. These well locations are shown in the Applicant's ER (Strata, 2011a).

The two industrial wells, completed at depths of 163 m and 229 m [536 ft and 750 ft], were permitted in the early 1980s and provide water for enhanced oil recovery (EOR). Water used in EOR is injected into the oil-bearing rock to displace oil from the rock, thus allowing the oil to be pumped to the surface. Well No. 19X-18 was originally used by Nubeth as a recovery well for its research and development activities, before being converted to a water-supply well for the nearby oil production. The Applicant's review of the well permit reports listed in the WSEO database during 2010 determined general information about each well (WSEO, 2006; Strata, 2011a). Completion depths of permitted stock wells range from 10 – 93 m [40 – 304 ft]. Domestic wells are generally deeper than the stock wells, ranging from 46 – 180 m [150 – 600 ft]. The limited information available on these wells precluded a determination of which aquifer was supplying water to the domestic wells.

The water-supply wells were sampled in consecutive quarters in 2009 and 2010 with the same methods established for the monitoring wells (Strata, 2011a). The results of the water-quality analyses are provided in the Applicant's ER (Strata, 2011a; Strata, 2011b). Comparison between the measured water quality and WDEQ's standards and EPA's drinking- water standards are also provided in the Applicant's ER (WDEQ/WQD, 2005b; 40 CFR Part 141; Strata, 2011a). As described below for each type of well, these analyses showed that the local water supply's contaminants generally exceeded EPA's drinking water standards and often exceeded Wyoming's less stringent quality standards for agricultural use.

Domestic Wells

TDS in samples from the domestic wells consistently exceeded the Wyoming Class I (Domestic) use and the EPA Secondary MCL standards. Sulfate exceeded the Wyoming Class I, the Wyoming Class II and the EPA Secondary MCL standards in 7 of the 13 wells sampled. Gross alpha in excess of the Wyoming Class I and Class II standards, as well as the EPA Primary MCL of 0.55 Bq/L [15 pCi/L], was measured in samples from 4 of the 13 domestic wells. The Wyoming Class I and the EPA Secondary MCL iron standards were exceeded in two of the wells.

Industrial Wells

Samples from the industrial wells exceeded the Wyoming Class II standard and the EPA Secondary MCL standards for TDS and sulfate. The Wyoming Class II and the EPA MCL standards were exceeded in Well No. 19XX18 for radiological parameters: uranium, radium-226+228, and gross alpha. The gross-alpha standard was also exceeded in samples from Well No. 22X-19.

Stock Wells

The water quality of stock wells is variable. TDS often ranged from 370 to 1,610 mg/L, often exceeding the EPA Secondary MCL standard, but also consistently less than the Wyoming Class II use standard of 2,000 mg/L. Sulfate, ranging from 28 to 679 mg/L, often exceeded the Wyoming Class II and the EPA Secondary MCL standards. Gross alpha exceeded both the Class II standard and the MCL in 7 of the 15 stock wells. Selenium exceeded the Wyoming Class II and the EPA Primary MCL standards in one well.

Ground-Water Uses

In order to assess historical and current ground-water use, ground-water rights and unregistered water wells were investigated by the Applicant within the Ross Project area and the surrounding 3.2-km [2-mile] vicinity. Sources of data included WSEO-registered wells, landowner interviews, and field investigations (WSEO, 2006). The search revealed 119 ground-water rights and unregistered wells. The locations and uses of these wells are summarized in the Applicant's ER (Strata, 2011a). Historical ground-water use began with the first domestic and livestock well in 1918. From approximately 1918 – 1977, ground water was used primarily for domestic and livestock consumption, with lesser amounts of water used for irrigation.

In 1977, Nubeth permitted 14 monitoring and industrial-use wells associated with its research and development operation. In addition, between 1980 and 1991, many industrial and miscellaneous wells associated with oil and gas production were permitted in and around the Ross Project area. These include three wells within the Ross Project area itself (Nos. P50917W, P67746W and P67747W) that are currently used as water-supply wells for EOR operations (i.e., water flooding) (Strata, 2011a). In 1981, International Minerals & Chemical Corporation (IM&CC) permitted five pits (Nos. P58895W, P58896W, P58899W, P58902W and P58905W) for dewatering and dust suppression associated with bentonite mining. According to WSEO records, the water rights were cancelled prior to 2001 at the request of IM&CC.

Between 1991 and 2009, the only ground-water rights that have been filed within the Ross Project and surrounding areas are for domestic and livestock use. In 2009, the Applicant obtained ground-water rights for its pre-licensing baseline monitoring wells. The historical ground-water use within the Ross Project area is summarized in Table 3.9.

Table 3.9
Historical Ground-Water Use within
Three Kilometers [Two Miles] of Ross Project Area

Use	Number of Wells	Percent of Total Use	Appropriation Dates
Domestic Only	5	4	1943 – 1995
Domestic and Stock	15	13	1918 – 2003
Domestic, Stock, and Irrigation	1	<1	1972 – 1972
Stock Only	34	29	1933 – 2010
Stock and Irrigation	1	<1	1961 – 1961
Monitoring	39	33	1977 – 2010
Industrial or Miscellaneous	24	20	1977 – 1991
TOTAL	119	100	1918 – 2010

Source: Strata, 2011a.

Within the Ross Project area, ground-water use follows a similar pattern to that observed within the 3.2-km [2-mile] surrounding vicinity, except that historical use has been livestock only (no domestic or irrigation use). More recent uses include monitoring-well use as well as industrial uses associated with Nubeth and with water supply for oil and gas operations. Most of the ground-water rights represented in Table 3.9 have been cancelled or are no longer active. Current ground-water use is limited to four livestock wells, the Applicant's regional pre-licensing baseline monitoring wells, and three industrial wells (i.e., water supply for oil and gas production). The stock wells are completed at total depths ranging from 39 – 81 m [128 – 265 ft], which are considerably above the ore-zone aquifer. The currently operating, industrial water wells are completed at total depths of 163 – 229 m [536 – 750 ft]. Together, these wells withdraw an average of approximately 1.9 L/s [30 gal/s] from the ore-zone aquifer.

3.6 Ecology

The Proposed Action is located within the Powder River Basin of the Northwest Great Plains ecoregion. As described in the GEIS, this area is characterized by rolling prairie and dissected river breaks surrounding the Powder, Cheyenne, and Upper North Platte Rivers (NRC, 2009b). Vegetation within this region is composed of sagebrush and mixed-grass prairie dominated by blue grama (*Bouteloua gracilis*), western wheatgrass (*Pascopyrum smithii*), needle-and-thread grass (*Stipa comata*), rabbitbrush (*Chrysothamnus sp.*), fringed sage (*Artemisia frigida*), and other forbs, shrubs, and grasses (NRC, 2009b).

The Applicant has conducted a number of ecological studies of the proposed Ross Project area to address the guidelines indicated in NUREG–1569, including the identification of important species and their relative abundance, and to meet the applicable Wyoming requirements (NRC, 2003). These studies included vegetation and wildlife surveys conducted on the Ross Project area in late 2009 and 2010 (Strata, 2011a).

3.6.1 Terrestrial Species

3.6.1.1 Vegetation

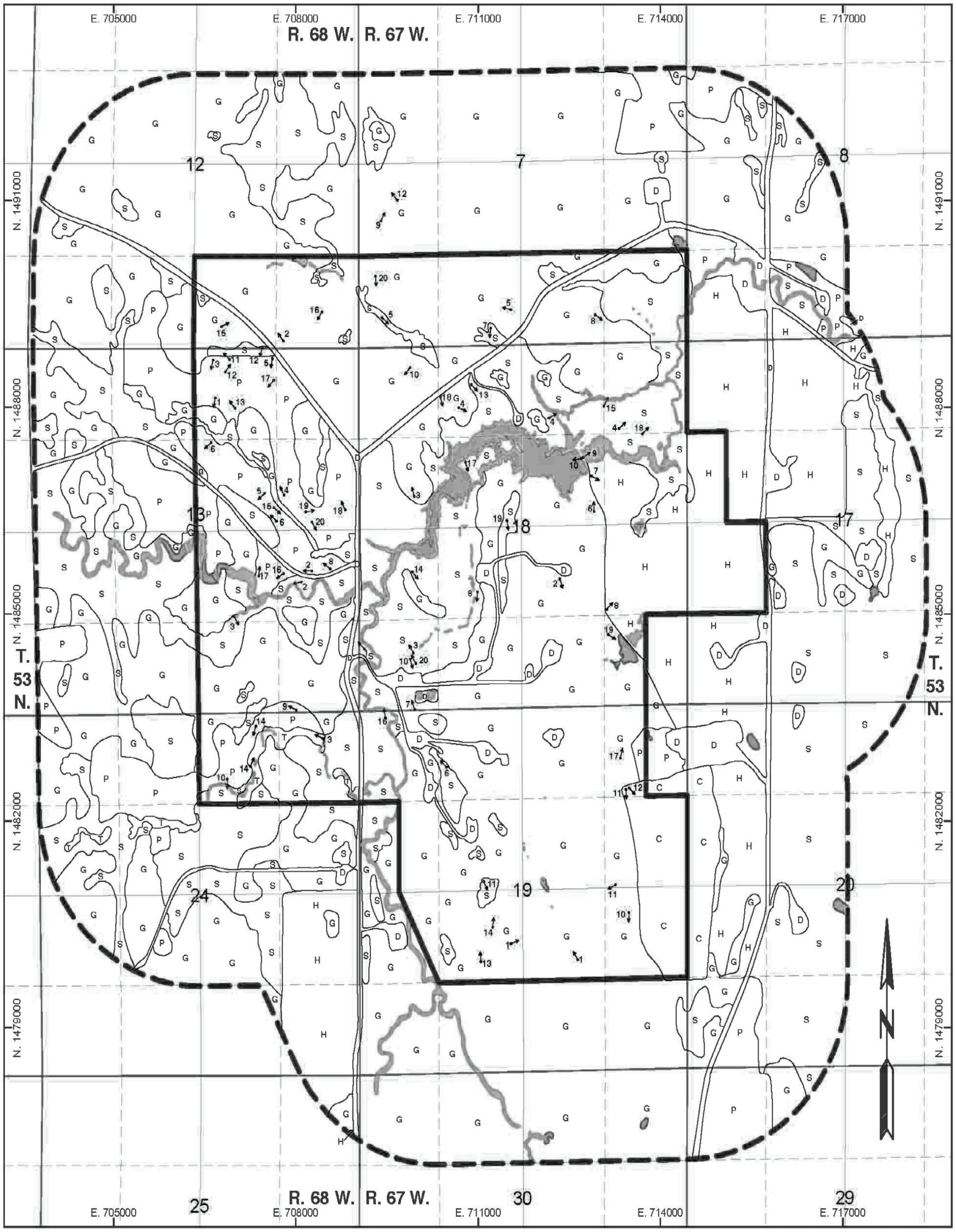
The Applicant conducted pre-licensing baseline vegetation and wetland surveys during 2009 and 2010, in accordance with State and Federal guidelines (Strata, 2011a). The spatial distribution of the vegetation types within the Ross Project area are shown in Figure 3.16. The vegetation mapped at the Ross Project area included upland grassland, sagebrush shrubland, pastureland, hayland, reservoir/stock pond, wetland, disturbed land, cropland, and wooded draw. No threatened or endangered plant species have been documented on the Ross Project area.

Each vegetation community was investigated by the Applicant to establish a baseline in support of the Proposed Action. In terms of diversity, the sagebrush-shrubland vegetation type exhibited the highest total number of individual plant species recorded in 2010, followed by the upland-grassland and pasture-land vegetation types (see Table 3.10).

Table 3.10
Species Diversity by Vegetation Type at Ross Project Area

Species Type	Number of Individual Plant Species Recorded		
	Sagebrush Shrubland	Upland Grassland	Pastureland
Perennials			
Grass	16	16	9
Grass-like	2	2	0
Forb	28	27	6
Subshrub	4	4	1
Full Shrub	5	1	1
Succulent	1	1	0
Subtotal	**56**	**51**	**17**
Annuals			
Grass	2	2	0
Forb	7	3	1
Subtotal	**9**	**5**	**1**
TOTAL	**65**	**56**	**18**

Source: Strata, 2011a.



Source: Strata, 2012a.

Drawing Coordinates: WY83EF

Figure 3.16

Baseline Vegetation at Ross Project Area

Several species of designated and prohibited noxious weeds listed by the *Wyoming Weed and Pest Control Act* were identified on the Ross Project area. These species included field bindweed (*Convolvulus arvensis*), perennial sow thistle (*Sonchus arvensis*), quackgrass (*Agropyron repens*), Canada thistle (*Cirsium arvense*), houndstongue (*Cynoglossum officinale*), leafy spurge (*Euphorbia esula*), common burdock (*Arctium minus*), Scotch thistle (*Onopordum acanthium*), Russian olive (*Eleagnus angustifolia*), and skeletonleaf bursage (*Ambrosia tomentosa*). These weed species may be locally abundant in small areas, especially around the Oshoto Reservoir and along the Little Missouri River and Deadman Creek, but they were not common throughout the entire area of the Ross Project.

Selenium-indicator species identified on the Ross Project area in 2010 included two-grooved milkvetch (*Astragalus bisulcatus*), woody aster (*Xylorhiza glabriuscula*), and stemmy goldenweed (*Haplopappus multicaulis*); however, these indicator species were not abundant. Little larkspur (*Delphinium bicolor*), locoweed (*Oxytropis sericea* and *Oxytropis lambertii*), and meadow deathcamas (*Zigadenus venenosus*) are poisonous plants that were observed on the Ross Project area in limited numbers (locoweed is only poisonous for cattle). Cheatgrass (*Bromus tectorum*), although not a State-listed noxious weed, was abundant in some areas within the Ross Project area (Strata, 2011a).

3.6.1.2 Wildlife

<u>Habitat Description</u>

Background information on terrestrial vertebrate wildlife species in the vicinity of the Ross Project area was obtained from several sources, including records from the WGFD, BLM, and USFWS as well as from GEIS Section 4.4.5 (NRC, 2009b). Previous site-specific data for the Ross Project area and its surrounding environs were obtained from those same sources and Nubeth's *Environmental Report Supportive Information* (ND Resources, 1977). In addition, the Applicant completed site-specific wildlife surveys from November 2009 through October 2010 to establish one year of baseline site-characterization data (Strata, 2011a). Over 140 different species were noted during these surveys or documented by other sources, e.g. WGFD (see Table 3.11). The surveys also focused on the Applicant obtaining information regarding bald eagles' winter roosts; however, all nesting raptors, threatened and endangered species, the BLM's Sensitive Species (BLMSS), and the USFWS's "Migratory Bird Species of Management Concern in Wyoming" (SMC) (also known as "Migratory Birds of High Federal Interest") were included in the survey procedures. Surveys were also conducted on the Ross Project area for swift fox, breeding birds, and northern leopard frogs. In addition to those species that were targeted, others were noted when observed.

Table 3.11
Wildlife Species Observed on or near Ross Project Area

Scientific Name	Common Name
Mammals	
Sylvilagus audubonii	Desert Cottontail
Lepus californicus	Black-tailed Jackrabbit
Lepus townsendii	White-tailed Jackrabbit

Table 3.11 Wildlife Species Observed on or near Ross Project Area (Cont.)	
Scientific Name	**Common Name**
Mammals (*Continued*)	
Tamias minimus	Least Chipmunk
Spermophilus tridecemlineatus	Thirteen-lined Ground Squirrel
Cynomys ludovicianus	Black-tailed Prairie Dog
Sciurus niger	Eastern Fox Squirrel
Thomomys talpoides	Northern Pocket Gopher
Dipodomys ordii	Ord's Kangaroo Rat
Castor Canadensis	Beaver
Peromyscus maniculatus	Deer Mouse
Neotoma cinerea	Bushy-tailed Woodrat
Microtus 0ochrogaster	Prairie Vole
Ondatra zibethicus	Muskrat
Erethizon dorsatum	Porcupine
Canis latrans	Coyote
Vulpes vulpes	Red Fox
Procyon lotor	Raccoon
Mustela frenata	Long-tailed Weasel
Taxidea taxus	Badger
Mephitis mephitis	Striped Skunk
Felis concolor	Mountain Lion
Felis rufus	Bobcat
Cervus elaphus	American Elk
Odocoileus hemionus	Mule Deer
Odocoileus virginianus	White-tailed Deer
Antilocapra americana	Pronghorn
Birds	
Branta canadensis	Canada Goose
Cygnus buccinator	Trumpeter swan
Cygnus columbianus	Tundra Swan
Anas strepera	Gadwall
Anas americana	American Wigeon
Anas platyrhynchos	Mallard
Anas discors	Blue-winged Teal
Anas crecca	Green-winged Teal
Anas cyanoptera	Cinnamon Teal
Anas clypeata	Northern Shoveler
Anas acuta	Northern Pintail
Aythya valisineria	Canvasback
Aythya americana	Redhead
Aythya collaris	Ring-necked Duck
Aythya affinis	Lesser Scaup

Table 3.11
Wildlife Species Observed on or near Ross Project Area (Cont.)

Scientific Name	Common Name
Birds (*Continued*)	
Bucephala albeola	Bufflehead
Oxyura jamaicensis	Ruddy Duck
Podilymbus podiceps	Pied-billed Grebe
Podiceps auritus	Horned Grebe
Podiceps nigricollis	Eared Grebe
Pelecanus erythrorhynchos	White Pelican
Phalacrocorax auritus	Double-crested Cormorant
Ardea herodias	Great Blue Heron
Cathartes aura	Turkey Vulture
Pandion haliaetus	Osprey
Haliaeetus leucocephalus	Bald Eagle
Circus cyaneus	Northern Harrier
Accipiter striatus	Sharp-shinned Hawk
Accipiter cooperii	Cooper's Hawk
Buteo swainson	Swainson's Hawk
Buteo jamaicensis	Red-tailed Hawk
Buteo regalis	Ferruginous Hawk
Buteo lagopus	Rough-legged Hawk
Aquila chrysaetos	Golden Eagle
Falco sparverius	American Kestrel
Falco mexicanus	Prairie Falcon
Centrocercus urophasianus	Greater Sage-grouse
Tympanuchus phasianellus	Sharp-tailed grouse
Meleagris gallopavo	Wild Turkey
Porzana carolina	Sora Rail
Fulica americana	American Coot
Charadrius vociferous	Killdeer
Recurvirostra americana	American Avocet
Actitis macularia	Spotted Sandpiper
Bartramia longicauda	Upland Sandpiper
Gallinago delicata	Wilson's Snipe
Phalaropus tricolor	Wilson's Phalarope
Larus californicus	California Gull
Larus argentatus	Herring Gull
Chlidonias niger	Black Tern
Columba livia	Rock Pigeon
Zenaida macroura	Mourning Dove
Bubo virginianus	Great Horned Owl
Asio flammeus	Short-eared Owl
Chordeiles minor	Common Nighthawk
Ceryle alcyon	Belted Kingfisher

Table 3.11
Wildlife Species Observed on or near Ross Project Area (Cont.)

Scientific Name	Common Name
Birds (*Continued*)	
Picoides villosus	Hairy Woodpecker
Colaptes auratus	Northern Flicker
Contopus sordidulus	Western Wood-Pewee
Sayornis saya	Say's Phoebe
Tyrannus verticalis	Western Kingbird
Tyrannus tyrannus	Eastern Kingbird
Eremophila alpestris	Horned Lark
Tachyceneta bicolor	Tree Swallow
Tachycineta thalassina	Violet-green Swallow
Stelgidopteryx serripennis	Northern Rough-winged Swallow
Riparia riparia	Bank Swallow
Hirundo pyrrhonota	Cliff Swallow
Hirundo rustica	Barn Swallow
Cyanocitta cristata	Blue jay
Pica pica	Black-billed Magpie
Corvus brachyrhynchos	American Crow
Corvus corax	Common Raven
Parus atricapillus	Black-capped Chickadee
Sitta canadensis	Red-breasted Nuthatch
Salpinctes obsoletus	Rock Wren
Troglodytes aedon	House Wren
Sialia currucoides	Mountain Bluebird
Turdus migratorius	American Robin
Oreoscoptes montanus	Sage Thrasher
Toxostoma rufum	Brown Thrasher
Sturnus vulgaris	European Starling
Lanius ludovicianus	Loggerhead Shrike
Vermivora celata	Orange-crowned Warbler
Dendroica petechia	Yellow Warbler
Dendroica coronate	Yellow-rumped Warbler
Geothlypis trichas	Common Yellowthroat
Wilsonia pusilla	Wilson's Warbler
Spizella passerine	Chipping Sparrow
Spizella breweri	Brewer's Sparrow
Pooecetes gramineus	Vesper Sparrow
Chondestes grammacus	Lark Sparrow
Calamospiza melanocorys	Lark Bunting
Ammodramus savannarum	Grasshopper Sparrow
Junco hyemalis	Dark-eyed Junco
Calcarius mccownii	McCown's Longspur
Agelaius phoeniceus	Red-winged Blackbird

Table 3.11 Wildlife Species Observed on or near Ross Project Area (Cont.)	
Scientific Name	**Common Name**
Birds (*Continued*)	
Sturnella neglecta	Western Meadowlark
Xanthocephalus xanthocephalus	Yellow-headed Blackbird
Euphagus cyanocephalus	Brewer's Blackbird
Quiscalus quiscula	Common Grackle
Molothrus ater	Brown-headed Cowbird
Icterus bullockii	Bullock's Oriole
Carpodacus mexicanus	House Finch
Carduelis pinus	Pine Siskin
Passer domesticus	House Sparrow
Amphibians	
Ambystoma tigrinum	Tiger Salamander
Pseudaris triseriata maculate	Boreal Chorus Frog
Rana pipiens	Northern Leopard Frog
Reptiles	
Phrynosoma douglassi brevirostre	Eastern Short-horned Lizard
Sceloporus graciosus graciosus	Northern Sagebrush Lizard
Chelydra serpentina serpentina	Common Snapping Turtle
Chrysemys picta belli	Western Painted Turtle
Crotalus viridis viridis	Prairie Rattlesnake
Pituophis melanoleucas sayi	Bullsnake
Thamnophis elegans vagrans	Wandering Garter Snake
Fish	
Ameiurus melas	Black Bullhead
Lepomis cyanellus	Green Sunfish
Lepomis macrochirus	Bluegill
Catastomus commersoni	White Sucker

Source: Strata, 2011a.

Mammals

Pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), and white-tailed deer (*O. virginianus*) were the only big-game species that were observed on the Ross Project area during the 2009 and 2010 surveys (Strata, 2011a). American elk (*Cervus elaphus*) have been recorded in the area by the WGFD; however, none were observed during the Applicant's surveys. No crucial big-game habitats or migration corridors are recognized by the WGFD at the Ross Project or the surrounding 1.6-km [1-mi] vicinity.

Pronghorn antelope and mule deer are common but not abundant on the Ross Project area. Pronghorn herds were most often observed in sagebrush-shrubland and upland-grassland habitats, and the mule deer frequented the sagebrush-shrubland habitat (Strata, 2011a). Both species used haylands and cultivated fields in the area. White-tailed deer were not abundant, but they were observed in the riparian habitats and on the cultivated fields within and near the Ross Project area. Pronghorn antelopes' use of the Ross Project and surrounding areas has been classified by the WGFD as year long, and mule deer use within the areas as winter and year long. White-tailed deer and elk use has been classified by the WGFD as out of their normal range. The Ross Project is located within the WGFD North Black Hills pronghorn-herd unit, the Powder River and Black Hills mule deer-herd units, and the Thunder Basin and Black Hills white-tailed deer-herd units. The Ross Project area is not within a specific elk-herd unit, but it is included in the WGFD designated area referred to as "Hunt Area 129" (Strata, 2011a).

A variety of small- and medium-sized mammals could potentially be present on the Ross Project area. These mammals include a variety of predators and furbearers, such as coyote (*Canis latrans*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), bobcat (*Lynx rufus*), badger (*Taxidea taxus*), beaver (*Castor canadensis*), and muskrat (*Ondatra zibethicus*). Prey species that were observed included rodents (e.g., mice, rats, voles, gophers, ground squirrels, chipmunks, prairie dogs), jackrabbits (*Lepus spp.*), and cottontails (*Sylvilagus spp.*). These species are cyclically common and widespread throughout the vicinity, and they are important food sources for raptors and other predators. Each of these prey species was either directly observed during Strata's field surveys or was known to exist through the presence of burrow formation or of droppings. Jackrabbit and cottontail sightings were common.

While black-tailed prairie dogs (*Cynomys ludovicianus*) are listed as occurring in the general area of the Ross Project, no black-tailed prairie-dog colonies (important as habitat for black-footed ferrets) were located within the 1.6-km [1-mi] survey area. Other mammal species, such as the striped skunk (*Mephitis mephitis*), porcupine (*Erethizon dorsatum*), and various weasels (*Mustela spp.*) inhabit sagebrush grassland and riparian communities, and these species were recorded within the Ross Project area during the Applicant's wildlife surveys. No bat species were observed during the baseline surveys. There are no records of prior use of the Ross Project by swift fox (*Vulpes velox*), and none were observed during the 2009 or 2010 surveys.

Birds

Suitable habitat for several raptor species occurs at the Ross Project area and within the 1.6-km [1-mi] vicinity surrounding it. Several raptor species were observed during the wildlife surveys; these included the bald eagle, red-tailed hawk (*Buteo jamaicensis*), golden eagle (*Aquila chrysaetos*), ferruginous hawk (*Buteo regalis*), Swainson's hawk (*Buteo swainsoni*), northern harrier (*Circus cyaneus*), American kestrel (*Falco sparverius*), Cooper's hawk (*Accipiter cooperii*), Sharp-shinned hawk (*Accipiter striatus*), rough-legged hawk (*Buteo lagopus*), great horned owl (*Bubo virginianus*), and short-eared owl (*Asio flammeus*). Turkey vultures (*Cathartes aura*) and prairie falcons (*Falco mexicanus*) have also been recorded on the Ross Project area, but they were not seen during the Applicant's surveys.

In the vicinity of the Ross Project area, nests were observed for the ferruginous, red-tailed, and Swainson's hawks (Strata, 2011a). The only nest observed within the Project area itself was a Swainson's hawk's nest, which was observed to be inactive during the 2010 survey year. A total of seven intact nesting sites were observed within 1.6 km [1 mi] of the Ross Project area.

The wild turkey (*Meleagris gallopavo*), Greater sage-grouse (*Centrocercus urophasianus*), sharp-tailed grouse (*Tympanuchus phasianellus*), and mourning dove (*Zenaida macroura*) were observed at the Ross Project area by the Applicant. Mourning doves were recorded during the spring and summer months.

The Greater sage-grouse (*Centrocercus urophasianus*) is listed as a Federal candidate species and a Wyoming Species of Concern (WSOC) in Wyoming (75 FR 13090; WGFD, 2005a) (see SEIS Section 3.6.1.4, below). Potential sage-grouse habitat is present at the Ross Project area (upland grassland, sagebrush shrubland, pastureland, hayland, and reservoir/stock pond). Two leks, which is where male sage grouse congregate for competitive mating displays, have been recorded within several miles of the Ross Project. Leks assemble before and during the breeding season on a daily basis; the same group of males meet at traditional locations each season. However, the Ross Project area is not located in a region currently designated as a sage-grouse core area.

Breeding-bird surveys were conducted within the Ross Project area in four habitat types: upland grassland, sagebrush shrubland, pastureland/hayland, and wetland/reservoir. Twenty-seven species were recorded during the 2010 breeding-bird surveys. The Wetland/Reservoir habitat produced the greatest species diversity, with 19 species observed. The upland grassland habitat had the fewest species, with six species observed.

Natural aquatic habitats on the Ross Project occur at the Oshoto Reservoir and along the Little Missouri River. During the Applicant's wildlife surveys, 17 waterfowl and 8 shorebird species were observed. In these categories, the horned grebe (*Podilymbus podiceps*) and upland sandpiper (*Bartramia longicauda*) are the only USFWS's SMC observed within or near the Ross Project area.

3.6.1.3 Reptiles, Amphibians, and Aquatic Species

During the Applicant's baseline wildlife surveys in 2009 and 2010, the eastern short-horned lizard (*Phrynosoma douglassi brevirostre*) and northern sagebrush lizard (*Sceloporus graciosus graciosus*) were often observed. Other reptiles observed in the area included the bullsnake (*Pituophis cantenifer*), wandering garter snake (*Thamnophis elegans vagrans*), and the prairie rattlesnake (*Crotalus viridis viridis*).

Water is a limiting factor for wildlife on the Ross Project area, where only one stream flows occasionally; the Oshoto Reservoir is the major water feature within the Ross Project area. All other natural drainages are categorized as intermittent or ephemeral (see SEIS Section 3.5.1). The lack of deep-water habitat and perennial water sources decreases the potential for many aquatic species to exist. Three aquatic or semi-aquatic amphibian species and two aquatic reptiles were recorded during the Applicant's baseline surveys: the tiger salamander (*Ambystoma tigrinum*), boreal chorus frog (*Pseudacris triseriata*), northern leopard frog (*Rana pipiens)*, common snapping turtle (*Chelydra serpentine*), and western painted turtle (*Chrysemys picta*). All five species were heard and/or seen in the Oshoto Reservoir, Little Missouri River, or near stock reservoirs. All five species are common to the Ross Project and the vicinity as a whole. No egg masses were identified during the egg-mass surveys completed in early June 2010. The reason for their absence could have been that recent high winds could have broken up the egg masses and dispersed the individual eggs. During walking surveys along shorelines and riparian areas in August 2010, the leopard frog appeared to be quite common—over 500 individual adults were counted—while the chorus frog was uncommon.

The Applicant also conducted fish sampling from the Oshoto Reservoir in September 2010, under a WGFD Chapter 33 collection permit, as part of its establishing pre-licensing baseline radiological conditions for the Ross Project. The dominant fish population in the Oshoto Reservoir included black bullheads (*Ameiurus melas*) and green sunfish (*Lepomis cyanellus*); white suckers (*Catastomus* commeroni) and bluegill (*Lepomis macrochirus*) were also present. The sample fish from this population were stunted in size for their ages; high reproductive rates and limited predation leads to over-population and stunted growth. The Oshoto Reservoir and the other water bodies within the Ross Project area are not considered viable sport fisheries (see SEIS Section 3.2.2).

3.6.1.4 Protected Species

The Ute ladies'-tresses orchid (*Spiranthes diluvialis*) is Federally-listed as threatened. The species is a perennial, terrestrial orchid that occurs in Colorado, Idaho, Montana, Nebraska, Utah, Washington, and Wyoming. Within Wyoming, this orchid inhabits moist meadows with moderately dense but short vegetative cover. As noted in Fertig (2000), this species is found at elevations of 1,280 – 2,130 m [4,200 – 7,000 ft], though no known populations occur in Wyoming above 1,680 m [5,500 ft]. This species was not located during the Applicant's vegetation surveys, and it is not known to occur on or in the vicinity of the Ross Project area.

The blowout penstemon (*Penstemon haydenii*) is Federally listed as endangered, although it is not included on the list for Crook County. However, it is on the list for neighboring Campbell County, and the Applicant therefore evaluated the potential for the blowout penstemon to occur in the Ross Project area. This species is found exclusively in sparsely vegetated, early successional sand dunes or blowout areas at elevations of 1,786 – 2,268 m [5,860 – 7,440 ft] (Fertig, 2008). The Ross Project does not have sand-dune habitat, and it is outside of the elevation range in which this species is typically found. This species was not identified during Strata's vegetation surveys; appropriate habitat was not identified; and it is not known to occur on or in the vicinity of the Ross Project.

The black-footed ferret (*Mustela nigripes*) is a Federally listed endangered species, which inhabits prairie-dog colonies. A black-footed ferret survey was not required by USFWS requirements, because black-footed ferrets live exclusively in prairie-dog colonies, which are not present on or within 1.6 km [1 mi] of the Ross Project area (Strata, 2011a).

The bald eagle (*Haliaeetus leucocephalus*) was delisted from Federal threatened status in 2007, but it is still protected under the *Bald and Golden Eagle Protection Act* and the *Migratory Bird Treaty Act*. Potential habitat for bald eagle nesting and roosting activities is quite limited within the Ross Project because of the lack of trees. Bald eagles were observed from the Ross Project area during wildlife surveys that took place November and December of 2009 and January through September of 2010 (Strata, 2011a). No nests were observed, however, and the bald eagle is considered to be a winter migrant to the area.

The Greater sage-grouse (*Centrocercus urophasianus*) is Federally listed as a Candidate species, as a State of Wyoming's Species of Concern (WSOC), and as a BLMSS. On March 5, 2010, the USFWS published a finding in the FR stating that listing of the species was warranted but precluded by higher priority listing actions (75 FR 13909). The Governor of Wyoming issued Executive Order (EO) 2010-4 in August 2010 which sets out 12 provisions for oil- and gas-resource operations within core and noncore population areas to protect the species at the

State level (State of Wyoming, 2011). The WGFD published *Recommendations for Development of Oil and Gas Resources Within Important Wildlife Habitats* and the Wyoming Field Office of the BLM issued an instructional memorandum on March 5, 2010, which supplements the BLM's 2004 *National Sage-Grouse Habitat Conservation Strategy*, to be consistent with the Governor's Executive Order (EO) (WGFD, 2010; BLM, 2004; BLM, 2010a). The WGFD guidance was again updated in April 2010.

The Greater sage-grouse inhabits open sagebrush plains in the western U.S. and is found at elevations of 1,200 – 2,700 m [3,937 – 8,858 ft], corresponding with the occurrence of sagebrush habitat (69 FR 933). The Greater sage-grouse is a mottled brown, black, and white ground-dwelling bird that can be up to 0.6 m [2 ft] tall and 76 cm [30 in] in length (69 FR 933). Breeding habitat, referred to as leks (see SEIS Section 3.6.1.2), and stands of sagebrush surrounding leks are used by sage-grouse in early spring and are particularly important habitat because the birds often return to the same leks and nesting areas each year. Leks are generally more sparsely vegetated areas such as ridgelines or disturbed areas adjacent to stands of sagebrush habitat.

Two sage-grouse leks are known to occur within 3 km [2 mi] of the Ross Project area. The Oshoto Lek (Sections 28 and 29, T53N, 67W) and the Cap'n Bob Lek (Section 32, T53 N, R67W) have been identified; no other sage-grouse leks were identified during the wildlife surveys. Details of sage-grouse mating activities for these leks are summarized in Table 3.12. A ground survey of the Oshoto and Cap'n Bob leks were conducted by the Applicant on two days in April 2010. On the Cap'n Bob lek, a total of two males and one female were observed on one day, and two males were observed on the second day; no sage-grouse were observed at the Oshoto Lek during the survey. No broods or brood-rearing areas were identified during the Applicant's 2010 survey. In addition, no sage-grouse wintering areas were identified on the Ross Project area (Strata, 2011a).

Threats to this species' survival include habitat loss, agricultural practices, livestock grazing, hunting, and land disturbances from energy and mineral development as well as the oil and gas industry (Sage-Grouse Working Group, 2006). Although the two leks described earlier were recorded near the Ross Project, the Project area is not located within a designated sage-grouse core area. Additionally, although sharp-tailed grouse were observed on the Ross Project area during only the 2009 winter survey, they are considered year-long residents of the Project area.

Table 3.12 Summary of Sage-Grouse Activity in Oshoto and Cap’n Bob Leks		
Year of Survey Activity	**Oshoto**	**Cap’n Bob**
1985	6 males	No information
1988	0	"
1988	0	"
1991	0	"
1994	0	"
1997	0	"
2000	0	"
2001	5 males	"
2004	2 males	"
2007	0	10 males
2007	0	10 males
2010	0	2 males 1 female
2010	0	2 males

Source: Strata, 2011a.

The mountain plover (*Charadrius montanus*) is Federally proposed as threatened and is a Wyoming Species of Greatest Conservation Need. The species is a small bird approximately 17.8 cm [7 in] in height with light brown and white coloring. The mountain plover is a native of the short-grass prairie and is found in open, dry shrubland, or agricultural fields with short vegetation and bare ground. Prairie dogs and other burrowing animals provide highly suitable habitat for the mountain plover.

Mountain plover breeding habitat includes the western Great Plains and Rocky Mountain states extending from the Canadian border to northern Mexico (75 FR 37353). The prime breeding and nesting period for the mountain plover is from April 10 through July 10 (BLM, 2007a). In Wyoming, the greatest concentration of mountain plovers is found in the south central part of the state, but they can be found in every county (Andres 2009; UW, 2010). This bird is often found in areas with heavy grazing and landscapes with excessive surface disturbance. USFWS originally proposed this species as threatened on February 16, 1999 (64 FR 7587); the proposal was withdrawn on September 9, 2003, but it was reinstated on June 29, 2010 (68 FR 53083; 75 FR 37353). This species was not observed during either the 2009 or 2010 wildlife surveys (Strata, 2011a).

Table 3.13 lists species that occur in Crook County and that are Federally listed under the *Endangered Species Act* (ESA), State-listed under the *Final Comprehensive Wildlife Conservation Strategy for Wyoming*, or are listed as a BLMSS.

Table 3.13
Species of Concern in Crook County and at Ross Project Area

Common Name *Scientific Name*	USFWS Species of Management Concern (Level)[1]	BLM Sensitive Species	Wyoming Species of Concern Status[2]	Observed on the Ross Project Area
Mammals				
Hayden's Shrew *Sorex haydeni*			NSS4*	
Vagrant Shrew *Sorex vagrans*			NSS3*	
Long-eared Myotis *Myotis evotis*		Yes	NSS2*	
Northern Myotis *Myotis septentrionalis*			NSS2*	
Little Brown Myotis *Myotis lucifugus*			NSS3*	
Long-legged Myotis *Myotis volans*			NSS2*	
Fringed myotis *Myotis thysanodes*		Yes	NSS2*	
Hoary Bat *Lasiurus cinereus*			NSS4*	
Silver-haired Bat *Lasionycteris noctivagans*			NSS4*	
Big Brown Bat *Eptesicus fuscus*			NSS3*	
Black-tailed Prairie Dog *Cynomys ludovicianus*			NSS3*	Yes
Plains Pocket Gopher *Geomys bursarius*			NSS4*	
Olive-backed Pocket Mouse *Perognathus fasciatus*			NSS3*	
Silky Pocket Mouse *Perognathus flavus*			NSS3*	
Western Harvest Mouse *Reithrodontomys megalotis*			NSS3*	
Prairie Vole *Microtus ochrogaster*			NSS3*	Yes
Sagebrush Vole *Lemmiscus curtatus*			NSS4*	
Swift Fox *Vulpes velox*		Yes	NSS4*	

Table 3.13
Species of Concern in Crook County and on the Ross Project Area
(*Continued*)

Common Name *Scientific Name*	**USFWS Species of Management Concern (Level)[1]**	**BLM Sensitive Species**	**Wyoming Species of Concern Status[2]**	**Observed on the Ross Project Area**
***Mammals* (*Continued*)**				
Black-footed Ferret *Mustela nigripes*			NSS1*	
Birds				
Waterfowl and Shorebirds				
Trumpeter swan *Cygnus buccinator*		Yes	NSS2	Yes
Northern Pintail *Anas acuta*			NSS3	Yes
Canvasback *Aythya valisineria*			NSS3	Yes
Redhead *Aythya americana*			NSS3	Yes
Lesser Scaup *Aythya affinis*			NSS3	Yes
Horned Grebe *Podiceps auritus*	Yes (NL)			Yes
Western Grebe *Aechmophorus occidentalis*			NSS4	
American Bittern *Botauosus lentiginosus*	Yes (I)		NSS3	
Great Blue Heron *Ardea herodias*			NSS4	Yes
Black-crowned Night-Heron *Nycticorax nycticorax*			NSS3	
White-faced Ibis *Plegadis chihi*		Yes	NSS3	
Sandhill Crane *Grus canadensis*			NSS3	
Mountain Plover *Charadrius montanus*	Yes (I)	Yes	NSS4*	
Upland Sandpiper *Bartramia longicauda*	Yes (I)		NSS4	Yes
Marbled Godwit *Limosa fedoa*	Yes (NL)			
Long-billed Curlew *Numenius americanus*	Yes (I)	Yes	NSS3*	

Table 3.13
Species of Concern in Crook County and on the Ross Project Area
(*Continued*)

Common Name *Scientific Name*	USFWS Species of Management Concern (Level)[1]	BLM Sensitive Species	Wyoming Species of Concern Status[2]	Observed on the Ross Project Area
Raptors				
Bald Eagle *Haliaeetus leucocephalus*	Yes (I)		NSS2	Yes
Northern Goshawk *Accipiter gentilis*		Yes	NSS4*	
Swainson's Hawk *Buteo swainsoni*			NSS4	Yes
Ferruginous Hawk *Buteo regalis*	Yes (I)	Yes	NSS3*	Yes
Golden Eagle *Aquila chrysaetos*	Yes (III)			Yes
Merlin *Falco columbarius*			NSS3*	
Peregrine Falcon *Falco peregrinus*	Yes (I)		NSS3*	
Prairie Falcon *Falco mexicanus*	Yes (III)			Yes
Burrowing Owl *Athene cunicularia*	Yes (I)	Yes	NSS4	
Short-eared Owl *Asio flammeus*	Yes (I)		NSS4	Yes
Upland Game				
Greater Sage-grouse *Centrocercus urophasianus*		Yes	NSS2	Yes
Other				
White Pelican *Pelecanus erythrorhynchos*			NSS3	Yes
Franklin's Gull *Larus pipixcan*			NSS3	
Forster's Tern *Sterna forsteri*			NSS3	
Black Tern *Chlidonias niger*			NSS3	Yes
Black-billed Cuckoo *Coccyzus erythropthalmus*	Yes (II)			
Yellow-billed Cuckoo *Coccyzus americanus*	Yes (II)	Yes	NSS2*	

Table 3.13
Species of Concern in Crook County and on the Ross Project Area
(*Continued*)

Common Name *Scientific Name*	**USFWS Species of Management Concern (Level)[1]**	**BLM Sensitive Species**	**Wyoming Species of Concern Status[2]**	**Observed on the Ross Project Area**
Other (*Continued*)				
Lewis's Woodpecker *Melanerpes lewis*	Yes (II)		NSS3*	
Willow Flycatcher *Empidonax traillii*	Yes (II)		NSS3	
Pinyon Jay *Gymnorhinus cyanocephalus*	Yes (IV)			
Pygmy Nuthatch *Sitta pygmaea*			NSS4*	
Sage Thrasher *Oreoscoptes montanus*	Yes (II)	Yes	NSS4*	Yes
Loggerhead Shrike *Lanius ludovicianus*	Yes (II)	Yes		Yes
Dickcissel *Spiza americana*	Yes (II)		NSS4	
Brewer's Sparrow *Spizella breweri*	Yes (I)	Yes	NSS4	Yes
Sage Sparrow *Amphispoza belli*	Yes (I)	Yes	NSS4	
Lark Bunting *Calamospiza melanocorys*	Yes (II)		NSS4	Yes
Baird's Sparrow *Ammodramus bairdii*	Yes (I)	Yes		
Grasshopper Sparrow *Ammodramus savannarum*	Yes (II)		NSS4	Yes
McCown's Longspur *Calcarius mccownii*	Yes (I)		NSS4	Yes
Chestnut-collared Longspur *Calcarius ornatus*			NSS4	
Bobolink *Dolichonyz oryzivorus*			NSS4	
Cassin's Finch *Carpodacus cassinii*	Yes (IV)			
Amphibians				
Tiger Salamander *Ambystoma tigrinum*			NSS4*	Yes
Plains Spadefoot *Scaphiopus bombifrons*			NSS4*	

Table 3.13 Species of Concern in Crook County and on the Ross Project Area (*Continued*)				
Common Name *Scientific Name*	**USFWS Species of Management Concern (Level)[1]**	**BLM Sensitive Species**	**Wyoming Species of Concern Status[2]**	**Observed on the Ross Project Area**
***Amphibians* (*Continued*)**				
Great Plains Toad *Bufo cognatus*			NSS4*	
Boreal Chorus Frog *Pseudaris triseriata maculate*			NSS4*	Yes
Bullfrog *Rana catesbeiana*			NSS4*	
Northern Leopard Frog *Rana pipiens*		Yes	NSS4*	Yes
Reptiles				
Northern Sagebrush Lizard *Sceloporus graciosus graciosus*			NSS4*	Yes
Western Painted Turtle *Chrysemys picta belli*			NSS4*	Yes
Prairie Rattlesnake *Crotalus viridis viridis*			NSS3*	Yes
Plains Hognose Snake *Heterondon nasicus nasicus*			NSS4*	
Bullsnake *Pituophis melanoleucas sayi*			NSS4*	
Wandering Garter Snake *Thamnophis elegans vagrans*			NSS4*	
Eastern Yellowbelly Racer *Coluber constrictor flaviventris*			NSS4*	

Source: Strata, 2011a.
Notes: See next page.

Notes for Table 3.13::

[1] *USFWS Level:*

- Level I (Conservation Action): Species clearly needs conservation action.
- Level II (Monitoring): The action and focus for the species is monitoring (M). Declining population trends and habitat loss are not significant at this point.
- Level III (Local Interest): Species that Wyoming Partners In Flight may recommend for conservation action that are not otherwise high priority but are of local interest (LI).
- Level IV (Not Considered Priority): Additional species of concern, but not considered a priority species.

[2] *WGFD Status:*

- NSS1: 1996 Nongame Bird and Mammal Plan Species of Special Concern with a Native Species Status of 1.
- NSS2: 1996 Nongame Bird and Mammal Plan Species of Special Concern with a Native Species Status of 2.
- NSS3: 1996 Nongame Bird and Mammal Plan Species of Special Concern with a Native Species Status of 3.
- NSS4: 1996 Nongame Bird and Mammal Plan Species of Special Concern with a Native Species Status *of 4.*

**Species listed wholly or in part due to absence of data.*

The Wyoming Field Office of the USFWS also uses the SMC list for conducting reviews related to non-coal, surface-disturbance projects. Thirty-two birds on the WSOC list were identified on this list for the Ross Project area (see Table 3.13). Surveys for avian WSOC, including sage-grouse, bald eagle, and mountain plovers, were conducted in 2009 and 2010 for the Ross Project area. Table 3.14 lists the avian WSOCs that were observed on the Ross Project area during the Applicant's 2009 and 2010 baseline surveys (Strata, 2011a), including their primary nesting habitats and historical occurrence in the general Ross Project vicinity.

In addition to the species previously discussed above, 20 bird species on the U.S. Fish and Wildlife Service's (USFWS's) SMC list could potentially be present within the Ross Project area. Of these 20 bird species, 7 have been observed within or near the Ross Project (see Table 3.13). Ten non-raptor or non-game bird species on the BLMSS list could potentially occur within the Ross Project. Of the ten bird species, four have been observed on or near the Ross Project area (see Table 3.14). Thirty-two non-raptor or non-game bird species on the WSOC list could potentially be present within the Ross Project area. Of the 32 bird species, 15 have been actually observed on or near the Project area (see Tables 3.13 and 3.14).

Table 3.14 Avian Species of Concern Observed at Ross Project Area		
Common Name ***Scientific Name***	**Primary Nesting Habitat(s)[1]**	**Status[2]**
Level 1 Species of Concern/Conservation Needed		
Bald Eagle *Haliaeetus leucocephalus*	Montane Riparian, Plains/Basin Riparian	Uncommon year-long resident
Ferruginous Hawk *Buteo regalis*	Shrub Steppe and Short-Grass Prairie	Summer uncommon resident
Upland Sandpiper *Bartramia longicauda*	Short-Grass Prairie	Summer uncommon resident
Short-eared Owl *Asio flammeus*	Short-grass Prairie and Meadows	Common year-long resident
Brewer's Sparrow *Spizella breweri*	Shrub Steppe and Mountain-Foothills Shrub	Common summer resident
McCown's Longspur *Calcarius mccownii*	Shrub steppe and short-grass prairie	Common summer resident
Level 2 Species of Concern/Continued Monitoring Recommended		
Sage Thrasher *Oreoscoptes montanus*	Shrub Steppe	Common summer resident
Loggerhead Shrike *Lanius ludovicianus*	Shrub Steppe	Common summer resident
Lark Bunting *Calamospiza melanocorys*	Shrub Steppe and Short-Grass Prairie	Abundant summer resident
Grasshopper Sparrow *Ammodramus savannarum*	Shrub Steppe and Short-Grass Prairie	Common summer resident
Level 3 Species of Concern/Species of Local Interest		
Golden Eagle *Aquila chrysaetos*	Specialized (Cliffs)	Common year-long resident
Prairie Falcon *Falco mexicanus*	Specialized (Cliffs)	Common year-long resident

Sources: USFWS, 2011, and USGS, 2011.

3.7 Meteorology, Climatology, and Air Quality

3.7.1 Meteorology

The region of the Ross Project area is characterized by hot summers and cold winters, and rapid temperature fluctuations are common. The Rocky Mountains (the “Rockies”) have a great influence on the climate. As air crosses the Rockies from the west, much moisture is lost on the windward sides of the Mountains, and the air becomes warmer as it descends on the eastern slopes (NRC, 2009b). The Ross Project area is located in this semi-arid area (Strata, 2011a).

The closest National Weather Service (NWS) station with a long recording period is Gillette Airport, which is located 56 km [35 mi] southwest of the Ross Project (Strata, 2011a). As the GEIS noted, there is a NWS station in Crook County, at Colony, Wyoming (72 km [45 mi] northeast of the Ross Project) (NRC, 2009b). This station, however, ceased operation in 2008. In addition, the Applicant has installed a site-specific meteorology station in 2010, where meteorology data has been collected every month since the station went online (Strata, 2011a).

Temperature

As described in the GEIS, the northwest Great Plains region has summer nights that are normally cool, even though daytime temperatures can be very warm. Winters can be quite cold; however, warm spells during winter months are common. The average temperatures for the two NWS stations in the vicinity of the Ross Project area, Colony and Gillette Airport, are shown in Table 3.15, in addition to the information collected by the Applicant in 2010 (NRC, 2009b; NWS, 2011; Strata, 2011a).

Table 3.15
Average, Minimum, and Maximum Temperatures in Ross Project Vicinity

Station	Average Temperature °C [°F]	Average Minimum Temperature °C [°F]	Average Maximum Temperature °C [°F]
Ross Project[1]	8.9 [48]	- 4.3 [24.3]	23.9 [75]
Gillette Airport[2]	8.1 [46.5]	N/A	N/A
Colony[3]	8.3 [47]	- 5.3 [22.5]	22.4 [72.3]

Source: Strata, 2011a; NRC, 2009b; NWS, 2011.
Notes: N/A = Data not available.
1 = Monitoring period 2010
2 = Monitoring period 1902 – 2009
3 = Monitoring period 1971 – 2000

At the Gillette Airport station, the warmest month of the year is July, with an average temperature of 23.6 °C [74.5 °F] (Strata, 2011a). The coldest month is December, with an average temperature of -4.7 °C [23.6 °F]. This trend was also observed at the Ross Project's meteorology station, with an average July temperature of 23.1 °C [73.6 °F] and an average December temperature of -4.7 °C [23 °F] for 2010.

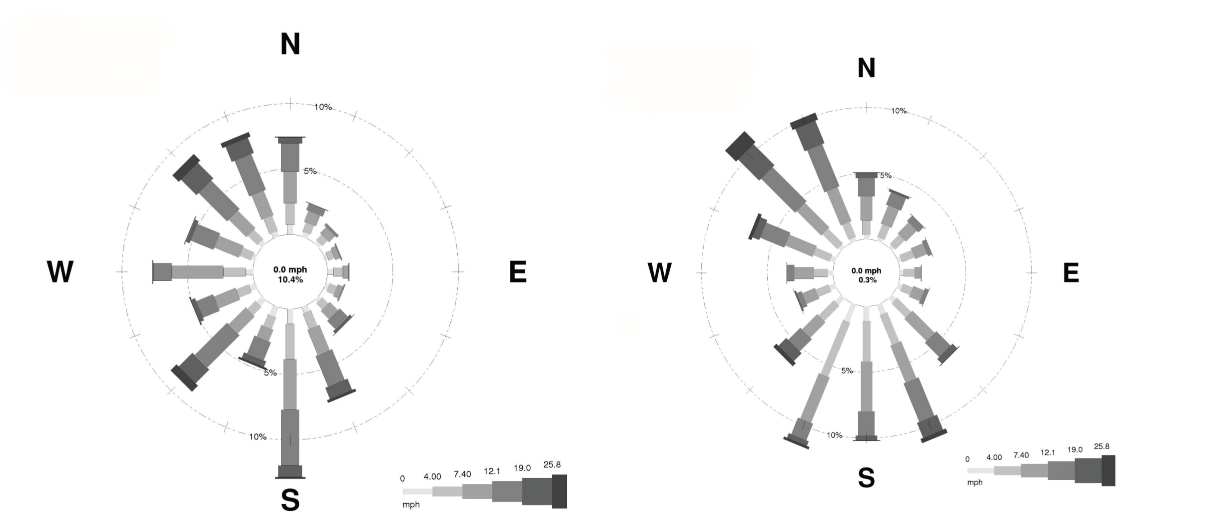
Wind

The average wind speed at the Gillette Airport station is 16.9 km/hr [10.5 mi/hr], with an average maximum wind speed from 2000 – 2009 of 77 km/hr [48 mi/hr] (Strata, 2011a). The highest winds were recorded in January through March, with the lowest speeds from July through September. As shown on the wind rose for the Ross Project area, the prevailing wind direction in the fall and winter is north/northwest (as shown in Figure 3.17), whereas in the spring and summer, the winds are generally from the southeast. The highest wind speeds tend to occur from the north-northwest.

During the 12 months of monitoring at the Applicant's meteorology station in 2010, the average annual wind speed was 18.5 km/hr [11.5 mi/hr], ranging from a minimum wind speed of 0 km/hr [0 mi/hr] to a maximum wind speed of 73.4 km/hr [45.6 mi/hr]. More southerly winds were recorded at the Ross Project than at the Gillette Airport station (as shown in Figure 3.18); however, as at Gillette Airport, the highest wind speeds are from the northwest.

Precipitation

The Ross Project area and the surrounding area receive relatively little rainfall, with average annual precipitation ranging from 25 – 38 cm [10 – 15 in]. The region receives an average annual snowfall of 127 – 152 cm [50 – 60 in]. At the Gillette Airport station, between 2005 – 2009, the average annual precipitation was measured at 30.5 cm [12 in] (Strata, 2011a). Approximately one-half of the precipitation is associated with spring snows and thunderstorms. May is the wettest month, with more than 5 cm [2 in] of precipitation, while January is the driest month, with average precipitation of approximately 1.3 cm [0.5 in] or less (Strata, 2011a).



Source: Strata, 2012a.

Figures 3.17 and 3.18

Gillette Airport Wind Rose (Left)
Ross Project Area Wind Rose (Right)

At the Applicant's onsite meteorology station, the total precipitation measured in 2010 was 24.8 cm [9.8 in], compared to 32.5 cm [12.8 in] for the same period at the Gillette Airport station (Strata, 2011a). The difference in precipitation during 2010 was primarily due to the fact that Gillette Airport received 6.4 cm [2.5 in] more in the month of May than the Ross Project. Otherwise, the monthly precipitation data are very similar.

Evaporation

As with the majority of the western U.S., the evaporation rate in northeastern Wyoming exceeds the rate of precipitation. As discussed in the GEIS, evaporation rates in the region range from 102 – 127 cm/yr [40 – 50 in/yr] (NRC, 2009b). An evaporation pan was installed at the Ross Project's meteorology station in June 2010; however, data are available from only June through late October 2010, because the gauge was removed to prevent its freezing. At the Gillette Airport station, evaporation in 2010 varied from slightly more than 10 cm [4 in] in April to almost 25 cm [10 in] in July and August. For the period of time the evaporation pan operated at the Ross Project, similar rates were observed (Strata, 2011a).

Atmospheric Stability Classification and Mixing Height

Atmospheric stability classification and mixing height are environmental variables that influence the ability of the atmosphere to disperse air pollutants. The stability class is a measure of atmospheric turbulence, and mixing height characterizes the vertical extent of contaminants mixing in the atmosphere. The nearest upper-air data available from the NWS are from Rapid City, South Dakota, approximately 170 km [106 mi] southeast of the Ross Project (Strata, 2011a). However, Rapid City is approximately 1,700 m [5,577 ft] lower in elevation than the Ross Project, and it is on the other side of the Black Hills. Therefore, the data are likely not representative of conditions at the Ross Project area.

Stability-class information was collected using the Applicant's meteorological station, which demonstrated that the class distributions were predominantly neutral approximately 62 percent of the time. Other calculated conditions were Stability Class D (17 percent) and Class E (Strata, 2011a). The classification that results in the least vertical mixing (Class F) was approximately 4.7 percent at the Ross Project area, while Classes A through C ranged from 3 percent to 6.7 percent (Strata, 2011a).

Average annual mixing heights were not reported, although Wyoming has provided statewide mixing heights to be used in dispersion modeling (see Table 3.16) (Strata, 2011a).

Table 3.16
Statewide Mixing Heights for Dispersion Modeling

Stability Class	Mixing Height (m [ft])
Class A	3,450 [11,319]
Class B	2,300 [7,546]
Class C	2,300 [7,546]
Class D	2,300 [7,546]
Class E	10,000 [32,808]
Class F	10,000 [32,808]

Source: Strata, 2011a.

Stability classes E and F are given an arbitrarily high number by the WDEQ/Air Quality Division (AQD) to indicate an absence of a distinct boundary in the upper atmosphere.

3.7.2 Climatology

On a larger scale, climate change is a subject of national and international interest. The recent compilation of the current scientific understanding in this area by the U.S. Global Change Research Program (GCRP), a Federal advisory committee, was considered in preparation of this SEIS (GCRP, 2009). Average temperatures in the U.S. have risen more than 1.1 °C [2 °F] over the past 50 years and are projected to rise more in the future. During the period from 1993 – 2008, the average temperature in the Great Plains increased by approximately 0.83 °C [1.5 °F] from 1961 to 1979 baseline temperatures (GCRP, 2009). The projected change in temperature over the period from 2000 – 2020, which encompasses the period that the Ross Project would be licensed, ranges from a decrease of approximately 0.28 °C [0.5 °F] to an increase of approximately 1.1 °C [3.4 °F]. Although the GCRP did not incrementally forecast a change in precipitation by decade, it did project a change in spring precipitation from the baseline period (1961 – 1979) to the next century (2080 – 2099). For the region in Wyoming where the Ross Project is located, the GCRP forecast a 10 – 15 percent increase in spring precipitation (GCRP, 2009).

The EPA has determined that potential changes in climate caused by greenhouse gases (GHG) emissions endanger public health and welfare based on a body of scientific evidence assessed by the GCRP as well as the National Research Council (74 FR 66496). The Administrator of the EPA has issued an endangerment finding based on a technical support document compiled by these scientific organizations. This endangerment finding specifies that, while ambient concentrations of GHG emissions do not cause direct adverse health effects (such as respiratory issues or toxic effects), public health risks and impacts can result indirectly from changes in climate. Based on the EPA's determination, the NRC recognizes that GHGs may have an effect on climate change. In Memorandum and Order CLI-09-21, the Commission provided guidance to NRC staff to consider carbon dioxide and other GHG emissions in its *National Environmental Policy Act* (NEPA) reviews (NRC, 2009a). GHG emissions, as projected for the Ross Project, are considered as an element of the air-quality impacts evaluation in this SEIS; GHG emissions are discussed in SEIS Section 5.

3.7.3 Air Quality

What is an air-quality attainment area?

The attainment status of an area refers to whether or not its air quality "attains" the National Ambient Air Quality Standards (NAAQS) for specific air pollutants. That is, an attainment area is a particular geographic area where the respective concentrations of primary (or "criteria") air pollutants meet the health-based NAAQS for the corresponding primary air pollutants. If the area persistently exceeds the NAAQS for one or more primary air pollutants, it is classified as being in "non-attainment" for the particular air pollutant(s) that exceed(s) the respective NAAQS standard. The Powder River Basin is an attainment area for PM_{10}.

As described in GEIS Section 3.4 (NRC, 2009b), all of the NSDWUMR is classified as an attainment area for all the primary criteria pollutants under the National Ambient Air Quality Standards (NAAQS) (NRC, 2009b). (The EPA sets NAAQS for air pollutants considered harmful to public health and the environment [40 CFR Part 50]. Some states, such as Wyoming, also set their own Ambient Air Quality Standards, such as the Wyoming Ambient Air Quality Standards [WAAQS].) Primary NAAQS are established to directly protect public health, and secondary NAAQS are established to protect public welfare by safeguarding against environmental and property damage. As discussed in GEIS Section 3.4.6, the NAAQS defines acceptable ambient-air concentrations for six common nonradiological particulate and gaseous air pollutants (i.e., primary or criteria pollutants): nitrogen oxides (as NO_2), ozone (O_3), sulfur oxides (as SO_2), carbon monoxide (CO), lead (Pb), and particulate matter (less than 10 and 2.5 μm in diameter [PM_{10} and $PM_{2.5}$]). In particular, most of the Powder River Basin, where significant coal mining activities are ongoing, and which includes the Ross Project area, is currently designated an attainment area for all pollutants (Strata, 2011a).

As noted above, states may develop standards that are more strict than or that supplement the NAAQS. The WDEQ/AQD has submitted a draft revision of its own WAAQS to the appropriate State boards. These revisions would result in Wyoming's adding one-hour NO_2 and SO_2 standards and revoking the current 24-hour and 1-hour standards for SO_2 of the existing WAAQS to be identical with NAAQS (see Table 3.17). The Wyoming-specific annual (arithmetic mean) PM_{10} standard of 50 μg/m^3, which is required for short-term modeling of surface coal mine emissions, will be retained. Some primary and secondary NAAQS are presented in Table 3.17 (WDEQ/AQD, 2010).

The air quality in the vicinity of the Ross Project area is currently in compliance with the NAAQS for all primary air pollutants, including particulates (i.e., fugitive dusts) and combustion-engine gaseous emissions.

Table 3.17
National and Wyoming Ambient Air Quality Standards

Criteria Pollutant	National Primary Standards	Wyoming Primary Standards	Averaging Time	Secondary Standards
Carbon Monoxide	9 ppm (10,000 µg/m^3)	9 ppm (10,000 µg/m^3)	8 Hours†	N/A*
	35 ppm (40,000 µg/m^3)	35 ppm (40,000 µg/m^3)	1 Hour†	N/A
Nitrogen Dioxide	0.053 ppm (100 µg/m^3)	0.05 ppm (100 µg/m^3)	Annual Arithmetic Mean	Same as Primary
	0.100 ppm (187 µg/m^3)	0.100 ppm (187 µg/m^3)	1 Hour	N/A
Particulate Matter (10-µm Diameter) (PM_{10})	150 µg/m^3	150 µg/m^3	24 Hours	Same as Primary
	N/A	50 µg/m^3	Annual Arithmetic Mean	N/A
Particulate Matter (2.5-µm Diameter) ($PM_{2.5}$)	12.0 µg/m^3	12.0 µg/m^3	Annual Arithmetic Mean	Same as Primary
	35 µg/m^3	35 µg/m^3	24 Hours[a]	Same as Primary
Ozone	0.08 ppm (157 µg/m^3)	0.08 ppm (157 µg/m^3)	8 Hours[b]	Same as Primary
Sulfur Oxides	N/A	*23 ppm* (*Will Revoke*) *60 µg/m^3*	Annual Arithmetic Mean	N/A
	N/A	*100 ppm* (*Will Revoke*) *260 µg/m^3*	24 Hours†	N/A
	75 ppm 200 µg/m^3	*75 ppm* (*Will Add*) *200 µg/m^3*	1 Hour	N/A
	N/A	0.5 ppm (1,300 µg/m^3)	3 hours†	0.5 ppm (1,300 µg/m^3)

Source: Modified from EPA's "National Ambient Air Quality Standards (NAAQS)," as of October 2011.
Notes:
† Not to be exceeded more than once per year.
* N/A = Not applicable.
[a] To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35.0 µg/m^3 (effective December 18, 2006).
[b] To attain this standard, the 3-year average of the fourth highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
Italics: Standard is in the rulemaking process in Wyoming. The intention is for WAAQS to reflect NAAQS, while retaining the State annual-average PM_{10} standard of 50 µg/m^3.

3.7.3.1 Particulates

"Particulates" refers to particles that are suspended in the air. Some particles are large enough to be seen (e.g., smoke and wind-blown dust), while others are too small to be visible. Agriculture, forestry, transportation, wind, and fire all contribute airborne particulates to the atmosphere. The NAAQS and WAAQS specify the allowable concentration of airborne particulates of 10 microns in diameter or smaller, or "PM_{10}," to 150 µg/m^3 [9.4 x 10^{-9} lb/ft^3] over 24 hours (see Table 3.17). Wyoming has a supplemental annual (arithmetic mean) PM_{10} standard of 50 µg/m^3 [3.1 x 10^{-9} lb/ft^3] that is averaged over the year (WDEQ/AQD, 2010). The NAAQS also limits allowable concentrations of airborne particles that are 2.5 microns in diameter or smaller ($PM_{2.5}$). Based on the pre-operational background data collected by the Applicant, three radionuclide particulates of interest (natural uranium, Ra-226 and Th-230) are found at concentrations at or below the minimum analytical detection limit and one radionuclide particulate (Pb-210) is found at concentrations just above the minimum analytical detection limits. The detected Pb-210 particulate levels are consistent with the background radon flux as Pb-210 is a progeny of the radon-222 decay.

The eastern portion of the Powder River Basin has an extensive network of PM_{10} monitoring stations that are operated by the mining industry because of the density of the coal mines in the region. There are five surface coal mines within approximately 48 km [30 mi] of the Ross Project area. PM_{10} compliance with the NAAQS and WAAQS 24-hour standards at these five mines (and, by inference, at the Ross Project area) has been consistently demonstrated by these stations (Strata, 2011a); However, there have been three small excursions over the 24-hour PM_{10} at the mines that were determined to be due to high wind conditions. There are also monitoring stations operated by the WDEQ/AQD in the cities of Sheridan, Gillette, Arvada, and Wright, where particulates are generally measured as PM_{10}.

The WDEQ/AQD operates a $PM_{2.5}$ particulate sampler at the Buckskin Mine, about 48 km [30 mi] west of the Ross Project area. Ambient air-quality monitoring data from 2005 – 2009 from the Buckskin Mine show that the average $PM_{2.5}$ ranged from 5.1 – 6.2 µg/m^3 [3.2 – 3.9 x 10^{-10} lb/ft^3], about one-third the annual mean $PM_{2.5}$ standard of 15 µg/m^3 [9.4 x 10^{-10} lb/ft^3]. No excursions above the 24-hour standard of 5 µg/m^3 were recorded at the Mine. The data indicate that particulates from highway and non-road-construction vehicles comprise approximately 28 percent of the total PM_{10} and $PM_{2.5}$ particulate emissions.

As discussed in GEIS Section 3.4.6, prevention of significant deterioration (PSD) requirements identify maximum allowable increases in concentrations for particulate matter for areas designated as in attainment. Different increment levels are identified for different classification areas, with Class I areas having the most stringent requirements. The nearest Class I areas to the Ross Project area is the Northern Cheyenne Indian Reservation (in Montana) and Wind Cave National Park (South Dakota); these areas are 130 km [80 mi] and 160 km [100 mi] from the Ross Project area, respectively. The other sensitive areas are the Class II Devils Tower and the Class II Cloud Peak Wilderness Area. These areas are approximately 16 km [10 mi] and 130 km [80 mi], respectively, from the Ross Project area (Strata, 2011a).

3.7.3.2 Gaseous Emissions

Existing regional air pollutants are known to include gaseous emissions, such as NO_2 and O_3, which have been extensively monitored near the Ross Project area and in the Powder River

Basin since 1975 (Strata, 2011a). See Table 3.17, which presents both the respective NAAQS and WAAQS gaseous-emission standards. Radon is a gaseous air emission which is described further in SEIS Section 3.12.1 under ***Air***. Based on the pre-operation background sampling, the radon concentrations in air through the Ross Project ranges from 0.5 to 2.0 pCi/L with a resultant exposure between 9.2 to 38.2 mrem. These values are consistent with expected background levels for radon in air overlying mineralized environments (Strata, 2011a).

Air-quality monitoring for gaseous emissions within the Powder River Basin includes measuring ozone (as O_3) and nitrous oxides (as NO_2) at two WDEQ/AQD stations, the closest of which is 29 km [18 mi] from the Ross Project area. A Wyoming Air Resources Monitoring System (WARMS), which is operated by the BLM, monitors sulfur- and nitrogen-oxide concentrations near Buffalo, Sheridan, and Newcastle. Nitrogen oxides (as NO_2) are also monitored by the WDEQ at the Thunder Mountain Basin National Grassland monitoring station, 29 km [18 mi] west of the Ross Project area as well as at private monitoring stations at the Belle Ayr and Antelope coal mines (see SEIS Section 5.2). All of these monitoring stations routinely indicate that the annual mean NO_2 emissions are well below the NAAQS and WAAQS.

Ozone is also monitored in the Powder River Basin which is considered an ozone attainment area. Although no violations of the ozone standard have occurred in the area, the levels reported by these nearby air-quality monitoring stations are sometimes close to the respective ozone standard.

PSD requirements also incorporate gaseous-emission standards (e.g., for NO_2, SO_2, and O_3) for maximum allowable increases in concentrations for areas designated as in attainment. As discussed above, Class I areas have the most stringent requirements; Class I areas nearest to the Ross Project area are listed above in SEIS Section 3.7.3.2.

3.8 Noise

As described in GEIS Section 3.4.6, eastern Wyoming is predominantly rural and undeveloped, except for the heavily mined Powder River Basin. Rural areas tend to be quiet, and natural phenomena, such as wind, rain, insects, and livestock, tend to contribute the most to background noise. The unit of measure used to represent sound-pressure levels is the decibel (dB) (and on the A-weighted scale, dBA or A-weighted decibel). dBA is a measure designed to simulate human hearing by placing less emphasis on lower frequency noises, because the human ear does not perceive sounds at low frequencies in the same manner as sounds at higher frequencies. In the undeveloped rural areas of Wyoming, the existing background ambient noise levels range from 22 decibels (dB) on calm days up to 38 dB, depending upon factors such as wind and traffic (NRC, 2009b).

How Is sound measured?

The human ear responds to a wide range of sound pressures. The range of sounds people normally experience extends from low to high pressures by a factor of 1 million. Sound is commonly measured using decibels (dB). Another common sound measurement is the A-weighted sound level (dBA). The equivalent sound level is expressed as an A-weighted sound level over a specified period of time—usually 1 or 24 hours. The A-weighting measures different sound frequencies and the variation of the human ear's response over the frequency range. Higher frequencies receive less A-weighting than lower ones.

What is noise?

Sound waves are characterized by frequency and measured in hertz (Hz). Noises that are perceptible to human hearing range from 31 to 20,000 Hz. Audible sounds (those that can be heard) range from about 60 dB at a frequency of 31 Hz to less than about 1 dB between 900 and 8,000 Hz. dBAs assume a human receptor to a particular noise-producing activity.

It should be noted that noise levels lessen with increasing distance from the respective source. Noise from a line source, such as a highway, is reduced by approximately 3 dB per doubling of distance. For example, road noise at 15 m [49 ft] from a highway is reduced by 3 dB at 30 m [98 ft] and further reduced by an additional 3 dB at 60 m [197 ft]. For point sources, such as equipment, compressors, and pumps, the reduction factor with distance is greater, at approximately 6 dB per doubling of distance.

The land uses in the Ross Project area (see Section 3.2) include livestock grazing, oil production, crop production, ordinary transportation, recreation, and wildlife habitat. Existing ambient noise levels at the Ross Project area were measured by the Applicant to establish pre-licensing baseline conditions at the residences located on New Haven Road and 11 residences in a 3-km [2-mi] vicinity of the Ross Project. Future site-specific noise levels associated with uranium-recovery activities would be measured against these baseline conditions to identify relative increases in noise levels.

The baseline noise study specifically studied the two nearest residences to the Ross Project. The first nearest residence is 210 m [690 ft] from the Ross Project's boundary and approximately 762 m [2,500 ft] from the location of the CPP in the Proposed Action. The second residence is 255 m [835 ft] from the boundary and 1,707 m [5,600 ft] from the proposed location of the CPP. Because these residences are so close to the Ross Project area, they bound the upper range of noise for all four of the residences next to the Ross Project area, where all of the residences are located within 0.48 km [0.3 mi] of the Ross Project's boundary (Strata, 2011a). The noise levels at these two residences averaged 35.4 dBA and 37.4 dBA, depending upon simultaneous factors such as wind speed, traffic volume, vehicular speed, and the type of load being transported (Strata, 2011a).

Truck traffic, in particular bentonite hauling from the Oshoto bentonite mine 5 km [3 mi] north of the Ross Project area and, less frequently, livestock hauling, are the main contributors to existing traffic noise on D and New Haven Roads. According to the U.S. Department of Transportation (USDOT), typical noise levels at road speeds ranging from 80 – 113 km/hr [50 – 70 mi/hr] are 62 – 68 dBA (passenger automobiles), 74 – 79 dBA (medium trucks), and 80 – 82 dBA (heavy trucks) (USDOT, 1995). Posted speed limits for D Road, which passes adjacent to the Ross Project area, are 88 km/hr [55 mi/hr] for automobiles and 72 km/hr [45 mi/hr] for trucks. Peak noise levels attributed to truck traffic have been measured at 80 – 90 dBA (Strata, 2011a). A passing truck hauling bentonite registered 73.4 dBA at the residence on New Haven Road.

In a separate noise study, the Applicant collected baseline measurements at the Applicant's Field Office for an entire week; the data yielded an average day-night noise level (l_{dn}) of 41.6 dBA overall, with no variance between weekday and weekend measurements (Strata, 2011a). The l_{dn} is the A-weighted equivalent noise level for a 24-hour period that includes a noise level at nighttime that is 10 dBA lower than the daytime noise level. Nighttime hours are considered to be from 10 p.m. to 7 a.m. (EPA, 1978).

The Wyoming Department of Transportation (WYDOT) has defined Noise Abatement Criteria (NAC) that take into account land use, because different land-use areas are sensitive to noise in different ways (NACs are used for impact determinations only). The WYDOT procedures consider a person to be affected by traffic noise from highways when existing or future sound levels approach or exceed the NAC, or when expected future sound levels exceed existing sound levels by 15 dBA. In addition, the sound characteristics of noise can affect the acceptability of noise levels to receptors and the acceptability of noise levels is increased when the noise is familiar and routine (WYDOT, 2011). There are no NACs for undeveloped land. The exterior of residential structures would be considered affected by highway traffic above 67 dBA $L_{eq(h)}$ (i.e., equivalent continuous noise level).

Ambient noise levels in larger communities would be expected to be similar to other urban areas (i.e., approximately 50 – 78 dBA). However, the nearest cities to the Ross Project are all quite distant from the Ross Project area and are, thus, not expected to be affected by the noise levels at the Ross Project (nor, conversely, affect the noise levels from the Ross Project). For example, Casper, Wyoming, which has a population of 55,000 and is 225 km [140 mi] away from the Ross Project area (USCB, 2010), and smaller communities, such as Hulett and Moorcroft, which are located 22 km [14 miles] and 35 km [22 miles] away from the Ross Project area, respectively, are too distant to contribute to the noise environment at the Ross Project area.

3.9 Historical, Cultural, and Paleontological Resources

Both NEPA and the *National Historic Preservation Act of 1966* (NHPA), as amended, require Federal agencies to consider the effects of their undertakings on historical and cultural properties. The historic preservation review process is outlined at regulations promulgated by the Advisory Council on Historic Preservation in 36 CFR Part 800. Historical properties are resources eligible for listing in the National Register of Historic Places (NRHP) and may include sites, buildings, structures, districts, or objects. Amendments to Section 101 of the NHPA in 1992 explicitly allowed properties of traditional religious and cultural importance to be eligible for inclusion on the NRHP (and the Wyoming Register of Historic Places). Eligible properties generally must be at least 50 years old and possess criteria of eligibility as defined in 36 CFR Part 60.4; these criteria include: 1) association with significant events in the past, 2) association with the lives of persons significant in the past, 3) embodiments of distinctive characteristics of type, period, or construction, or 4) yield or be likely to yield important information. Historical properties must also possess integrity, defined as the ability of a property to convey its significance (NPS, 1997a).

NEPA established the responsibility of the Federal government to employ all practicable means to preserve important historical, cultural, and natural aspects of national heritage. Implementing regulations for Section 106 provide guidance on how NEPA and Section 106 processes can be coordinated (at Section 800.8[a]) and set forth the manner in which the NEPA process and its documentation can be used to comply with Section 106 (Section 800.9[c]). The NHPA regulations also address the Federal government's responsibility to identify historical and cultural properties and assess the effects of a given Federal undertaking on those properties (Sections 800.4 through 800.5).

As a Federal undertaking, the issuance of an NRC source and byproduct material license for the Ross Project has the potential to affect historic properties located on, in, beneath, or near the Ross Project area. The NRC is required, in accordance with the NHPA, to make a reasonable effort to identify historic properties in the area of potential effect (APE) for the Project. The APE is defined by the Ross Project site boundary and its immediate environs, which may be impacted by the Ross Project construction, operation, aquifer restoration, and decommissioning activities. If historic properties are known to be present, the NRC is required to assess the effects of its issuing a license for uranium-recovery operations on identified properties and to resolve any adverse impacts to those properties.

Several additional statutes and EOs apply to Federal land managed by the BLM, most notably the *Native American Graves Protection and Repatriation Act* (NAGPRA) and the *Archaeological Resources Protection Act* (ARPA). NAGPRA is applicable to burials found on BLM-managed lands, and in that context provides for the protection of Native American remains, funerary objects, sacred objects, or objects of cultural patrimony, and their repatriation to affiliated Native American Tribes following a consultation process between Tribes and the land managing federal agency. ARPA regulates the permitting of archaeological investigations on public land, including those managed by BLM. The State of Wyoming also has a statute pertaining to archaeological sites and human remains, entitled *Archaeological Sites* (Wyoming Statute Ann. §36-1-114, et seq.). The Wyoming State Historic Preservation Office (SHPO) administers and is responsible for oversight and compliance review for Section 106 of the NHPA and NAGPRA as well as compliance with other Federal and State historic-preservation statutes and regulations. The Wyoming SHPO and the Wyoming State Office of the BLM have entered into a programmatic agreement that describes the manner in which the two entities would interact and cooperate under the BLM's National Programmatic Agreement.

3.9.1 Cultural Context of Ross Project Area

The following information is provided as an aid to the reader to understand the Ross Project area in terms of potential prehistoric and historic events that would reasonably be expected to have occurred and that would have left behind artifacts (archaeological resources) of interest to present-day archeologists, paleontologists, and present-day Native American Tribes of this area.

The Ross Project area is within a portion of Wyoming inhabited by aboriginal hunting and gathering people for more than 13,000 years. Throughout the prehistoric past, this area was used by highly mobile hunters and gatherers who exploited a wide variety of resources. The immense expanse of grassland in the Plains region was home to vast herds of bison, also known as buffalo. Exploitation of this resource by indigenous groups structured the Northwest Plains culture area. Fur traders, explorers, and military men were the first Euro-Americans to enter the region and encounter the mounted Indians of the region. These bison-dependent people and their way of life were eventually displaced by permanent farming and ranching settlement.

3.9.1.1 Prehistoric Era

Past research activities within the Northwestern Plains culture area have defined a sequence of cultural periods that provide a general context for identification and interpretation of archaeological resources within the proposed Ross Project area. This chronology for the

Northwestern Plains was developed from the work of Frison (1991; 2001) with age ranges provided in years Before Present (B.P.):

- Paleoindian period (13,000 – 7,000 years B.P.)
- Early Archaic period (7,000 – 5,000 years B.P.)
- Middle Archaic period (5,000 – 4,500 to 3,000 years B.P.)
- Late Archaic period (3,000 – 1,850 years B.P.)
- Late Prehistoric period (1,850 – 400 years B.P.)
- Protohistoric period (400 – 250 years B.P.)
- Historic period (250 – 120 years B.P.)

The most-recent two cultural periods, about which more is known, are more thoroughly discussed in a separate section below.

The Paleoindian period includes various complexes (Frison, 1991; Frison, 2001). Each of these complexes is correlated with a distinctive projectile point style derived from generally large, lanceolate and/or stemmed point morphology. The Paleoindian period is traditionally thought to be synonymous with the "big game hunters" who exploited megafauna such as bison and mammoth (Plains Paleoindian groups), although evidence of the use of vegetal resources has been noted at a few Paleoindian sites (foothill-mountain groups).

The Early Archaic period projectile point styles reflect the change from large lanceolate types that characterized the earlier Paleoindian complexes to large side- or corner-notched types. Subsistence patterns reflect exploitation of a broad spectrum of resources, with a much-diminished use of large mammals.

The onset of the Middle Archaic period has been defined on the basis of the appearance of the McKean Complex as the predominant complex on the Northwestern Plains around 4,900 years B.P. (Frison, 1991; Frison, 2001). McKean Complex projectile points are stemmed variants of the lanceolate point. These projectile point types continued until 3,100 years B.P. when they were replaced by a variety of large corner-notched points (e.g., Pelican Lake points) (Martin, 1999, as cited in Strata, 2011a). Sites dating to this period exhibit a new emphasis on plant procurement and processing.

The Late Archaic period is generally defined by the appearance of corner-notched dart points. These projectile points dominate most assemblages until the introduction of the bow and arrow around 1,500 years B.P. (Frison, 1991). This period witnessed a continual expansion of occupations into the interior grassland and basins, as well as the foothills and mountains.

The Late Prehistoric period is marked by a transition in projectile point technology around 1,500 years B.P. The large corner-notched dart points characteristic of the Late Archaic period are replaced by smaller corner- and side-notched points for use with the bow and arrow. Approximately 1,000 years B.P., the entire Northwestern Plains appears to have suffered an abrupt collapse or shift in population (Frison, 1991). This population shift appears to reflect a narrower subsistence base focused mainly on communal procurement of pronghorn antelope and bison.

3.9.1.2 Protohistoric/Historic Periods

The Protohistoric period witnessed the beginning of European influence on prehistoric cultures of the Northwestern Plains. Additions to the material culture include, most notably, the horse and European trade goods, including glass beads, metal, and firearms. Projectile points of this period include side-notched, tri-notched, and un-notched points, with the addition of metal points. Introduction of the horse on the southern Plains in the 1600s spread northward to other Tribes, and mounted buffalo hunters became the classic Plains culture known in the period of Euro-American contact. New diseases also spread across the continent with the first arrival of Europeans, affecting Native peoples even before the physical appearance of the newcomers.

The Plains Tribes shared a basic commonality of style in their material culture, with regional and Tribal variation. This material culture was strongly characterized by its dependence on bison. Bison played a part in all aspects of physical life by providing food, clothing, shelter, tools, and fuel (dung), as well as embodying a spiritual force (DeMallie, 2001). The need to follow the seasonal movements of bison herds resulted in seasonal variation in residential patterns. Summer encampments of large groups gathered to hunt, using cooperative hunting techniques such as driving a herd over a cliff (buffalo jump sites) or into a corral at the bottom of a slope or a cut bank.

Extended family and village groups moved along with the herds, hauling their belongings and portable dwellings to new encampments. Originally, long, low, multiple-family tents, the classic Plains teepee built on a foundation of supporting poles, developed following the adoption of the horse (DeMallie, 2001). Extended families were organized in nomadic bands or semi-sedentary villages, each independent but sharing the same language and culture, with the size of their aggregations determined by ecological factors. Communal hunting needed for the bison hunts gave way to smaller, scattered social groups that were optimal at other times. The need for horse pasturage also limited the size and duration of residential groups. Smaller Tribes stayed together more of the year, but large Tribes might only congregate for summer hunts. The largest Tribes, such as the Blackfoot and Crow, might rarely gather in a single place and tended toward more lasting divisions that can be viewed as separate Tribes with their own territories and linguistic distinctions (DeMallie, 2001).

Plains groups shared a fundamental belief in the power inherent in all living beings. This power was accessible to individuals in dreams and visions but was particularly useful to medicine men and priests, whose more heightened understanding and experience of power gave them a special role in the ritual life of Plains communities. Sacred power was acquired by individuals through vision seeking during a retreat and accompanied by fasting and prayer while awaiting the appearance of spiritual beings in a special form, sometimes an animal that embodied a teaching and protective spirit (DeMallie, 2001).

During the historic period, the Plains Tribes came under duress from the effects of a rapidly changing world. As soldiers, settlers, bison hunters, and other Tribal nations pushed westward, epidemic diseases ravaged the native populations, and the dislocation of conflict increased, leading to changing demographic patterns and a breakdown of traditional systems of food gathering and inter-group exchange patterns. As missionaries came onto the Plains they professed belief systems that conflicted with, and sometimes even forbade, native traditional rites related to a life view that often mingled the spirit and physical worlds. The influx of trading post goods, the shift in hunting patterns, and the loss of access to the seasonal migrations of prey produced a distorting effect that challenged native life. Cultural transformation was rapid, and was characterized by a long period of hostilities with the white settlers and disagreements among various Tribal entities regarding the course of action in the face of encroachment. Eventual resolution of conflict came through military means and treaties that established the present-day reservation system.

The only Tribal reservation in Wyoming is the Wind River Indian Reservation, located approximately 273.6 km [170 mi] southwest of the Ross Project. The Crow and Northern Cheyenne Indian Reservations in Montana (approximately 160 and 146 km [100 and 91 mi] northwest, respectively) and the Pine Ridge Indian Reservation in South Dakota (approximately 185 km [115 mi] southeast) are the other Tribal reservation communities nearest the proposed Ross Project site. A review of the literature indicates that Devils Tower, which is called *Mato Tipila* by some Native Americans which means “Bear Lodge” (other names for Devils Tower include: Bear’s Tipi, Home of the Bear, Tree Rock and Great Gray Horn) (NPS, 2012), (located approximately 18 km [10 mi] from the Ross Project) is a sacred area for several Plains Tribes (Hanson and Chirinos, 1991, as cited in Strata, 2011a). According to the U.S. National Park Service (NPS), over 20 Tribes have potential cultural affiliation with Devils Tower. Six Tribes (Arapaho, Crow, Lakota, Cheyenne, Kiowa, and Shoshone) have historical and geographical ties to the Devils Tower area (NPS, 1997b). Many Native American Tribes of the northern Plains refer to Devils Tower in their legends and consider it a sacred site.

3.9.1.3 Historic Era

The historical context of the Ross Project area includes several themes common to all of northeastern Wyoming. The earliest cumulative historic impact was associated with intermittent exploration, fur trapping, gold seeking, and military expedition, circa 1810s – 1870s. This era was followed by large-scale stock raising (1870s – 1900s). The dry-land farming/homesteading movement was the most substantial historic expansion, occurring from the 1910s – 1930s. The Great Depression resulted in the government assistance programs of the mid- to late-1930s, which affected the settlement patterns of this region. Post-war ranching (1945 to present) is the latest historic theme. Crook County, where the Ross Project is situated, was formed in 1875 and named for Brigadier General George Crook, a commander during the Indian Wars.

Although Euro-Americans began to pass through Wyoming in the early 1800s, these visits were limited to government expeditions of discovery and various British and American fur trapping brigades. Beginning in the 1840s, emigrants of the "great western migration" passed along the Oregon-California Trail along the Platte River and through South Pass heading for lands in Oregon, California, and the Salt Lake Valley, but few if any stayed on in the region. As the lands in the west became more populated and the cattle industry made its way into Wyoming in the 1860s, the region began to attract its own settlers.

The Texas Trail, which operated from 1876 – 1897, was used to move cattle as far north as Canada. Most of the early cattle herds passed through Wyoming and were used to establish Montana's ranching industry. As cattlemen recognized the value of Wyoming's grassland, several large cattle ranches were established and flourished until the devastating blizzards in the winter of 1886-1887. The close of the cattle baron era provided an opening for Wyoming's sheep industry. Several large ranches, including the 4J and G-M, were established in the Gillette area south of the proposed Ross Project; however, the industry experienced steady declines in the 1900s (Massey, 1992; Rosenberg, 1991, as cited in Ferguson, 2010). The dry-land farming movement of the late 19th and early 20th centuries had a profound effect on the settlement of northeastern Wyoming during the years around World War I. The most intensive period of homesteading activity in northeastern Wyoming occurred in the late 1910s and early 1920s. Promotional efforts by the State and the railroads, the prosperous war years for agriculture in 1917 and 1918, and the Stock Raising Act of 1916 with its increased acreage (but lack of mineral rights) all contributed to this boom period. It soon became evident, however, that dry-land farming alone would not provide a living and farmers began to increase their livestock holdings (Ferguson, 2010).

A severe drought in 1919 followed by a severe winter, along with a fall in market prices in 1920, forced out many small holders. During the 1920s the size of homesteads in Wyoming nearly doubled while the number of homesteads decreased, indicating the shift to livestock raising (LeCompte and Anderson 1982, as cited in Strata, 2011a). A period of drought began in 1932, leading to Federal drought relief programs. In April of 1932, the Northeast Wyoming Land Utilization Project began repurchasing the sub-marginal homestead lands and making the additional acres of government land available for lease. Two million acres within five counties, including about 226,624 ha [560,000 ac] of Federally-owned lands, were included in the Thunder Basin Project (LA-WY -1) to alter land use and to relocate settlers onto viable farmland (Resettlement Administration, 1936, as cited in Ferguson, 2010).

During the development program to rehabilitate the range, impounding dams were erected, wells were repaired, springs developed, and homestead fences removed while division fences were constructed for the new community pastures. The government paid former farmers to remove homesteads and their efforts were so successful that almost no trace remains. The remaining subsidized ranches were significantly larger and provided a stabilizing effect on the local economies. The Thunder Basin Grazing Association, the Spring Creek Association, and the Inyan Kara Grazing Association were formed to provide responsible management of the common rangeland.

Uranium was first discovered in Wyoming in 1918 near Lusk. Nuclear Dynamics and Bethlehem Steel Corporation formed the Nubeth Joint Venture (Nubeth) to develop new uranium recovery districts in the western U.S. with specific attention focused on northeastern Wyoming's Powder River Basin (Strata, 2011a). The initial discovery of uranium near Oshoto was made by Albert Stoick during an over-flight of the area. This was followed by macroscopic sampling efforts and then regional exploration work by the Nubeth Joint Venture (Nubeth) (Buswell, 1982, as cited in Strata, 2011a). Nubeth received a Wyoming Department of Environmental Quality/Land Quality Division (WDEQ/LQD) License to Explore (No. 19) in August 1976 and an NRC license in April 1978 (No. SUA-1331). The Nubeth research and development facility was constructed and operated from August 1978 through April 1979. No precipitation of a uranium product took place, however, and all recovered uranium was stored as a uranyl carbonate solution. All final approvals for Nubeth's decommissioning were granted by the NRC and WDEQ by 1986 (Strata, 2011a).

3.9.2 Historical Resources

Buildings and Structures

No buildings or structures eligible for the NRHP or Wyoming State Register were identified within the Ross Project area (Ferguson, 2010). An earthen structure in the Ross Project area, the Oshoto Dam, did not meet the criteria for eligibility for listing in the NRHP (48 CFR Part 2157). The original dam has been rebuilt numerous times because of flood damage, most recently in 2005, and is considered to be essentially a reconstruction rather than the original dam.

Archaeological Sites

A Class III Cultural Resource Inventory (Class III Inventory) was conducted in support of the Ross Project in April 2010 and July 2010 (Ferguson, 2010). The Inventory included a pedestrian survey in transects of 30-m [102-ft] intervals throughout the Ross Project area. Subsurface exposures such as cut banks, anthills, rodent burrows, roads ruts, and cow tracks were examined. Shovel probes were placed at the discretion of the surveyors, primarily in locations where artifacts or features were located or where soil had accumulated. The Inventory focused on landforms where intact sites might be expected, such as intact, stable terraces and their margins as well as areas of exposure (Ferguson, 2010). In November 2011, a geophysical investigation consisting of a magnetometer survey was conducted at several sites within the Ross Project Area and additional shovel tests were conducted in May 2012 and June 2012.

In preparation for the Class III Inventory, a Class 1 Inventory (i.e., a records search) was conducted for the Ross Project area in 2010; this search included the records of the Wyoming Cultural Records Office (WYCRO), the WYCRO online data base, and the BLM's Newcastle Field Office (Ferguson, 2010).

The records search showed that, prior to the 2010 Class III Inventory, no substantial block inventory (i.e., survey) had been conducted in the Project area. Small-scale investigations, including two associated with power lines and buried telephone cables as well as a drilling-pad and access-road survey, have been conducted in the Ross Project area. Only one survey, an inventory for a linear buried telephone cable in Section 13, identified one prehistoric campsite, 48CK1603. Avoidance of this campsite was recommended as a result. The campsite lies on both State of Wyoming and private land, and it was described as "bisected" by D Road (Ferguson, 2010).

During the Applicant's Class III Inventory for the Ross Project, 24 new sites and 21 isolated finds were recorded. Twenty-three of the recorded sites are prehistoric camps, and one is a historic-period homestead. The 24 sites along with the previously identified 48CK1603 are listed in Table 3.18. Paleontological materials, believed to be out of context, were found at two of the sites. These two sites produced projectile points that represent Middle Archaic and Late Archaic periods; other fragments found indicate Late Prehistoric-period occupation. Twenty-one isolates were also recorded during the Inventory. All but two of these are prehistoric artifacts; the two historic isolates are trash scatters. In addition to the sites identified during the Class III Inventory, the potential exists for deeply buried sites to be found within the Ross Project area because of its propitious location near the headwaters of the Little Missouri River.

Fifteen sites identified for the Ross Project have been recommended by the Applicant as eligible for the NRHP (Ferguson, 2010). These are: Nos. 48CK1603, 48CK2073, 48CK2075, 48CK2076, 48CK2078, 48CK2079, 48CK2080, 48CK2081, 48CK2082, 48CK2083, 48CK2085, 48CK2089, 48CK2090, 48CK2091, and 48CK2092. All of these sites are considered eligible under Criterion D of the NRHP, because they are likely to yield information important to our knowledge of prehistory. Collectively or individually, the sites have the potential to yield important information about the occupations at the headwaters of the Little Missouri River and possibly to add to the understanding of the prehistoric cultural relationships between the Little Missouri River region and the Powder River Basin. Two of the sites, Nos. 48CK2083 and 48CK2091, also provide temporal information (Ferguson, 2010).

In general, the Class III Inventory considered that sites located on intact terrace settings, where site preservation was sufficient for research purposes, were recommended as eligible. The remaining nine sites, where landforms lacked soil development and surfaces were eroded or deflated, were not considered likely to retain additional research potential. The NRC staff is in the process of consulting with the Applicant, interested Tribes, and Wyoming SHPO to evaluate the archaeological sites identified during the Applicant's Class III Inventory.

3.9.3 Cultural Resources

Implementing regulations for NHPA, specifically 36 CFR Part 800.4l(a)(1), require the NRC to determine and document the respective APE in consultation with the Wyoming SHPO and the Tribal Historic Preservation Offices (THPOs) (36 CFR Part 800). The definition of an APE is defined in 36 CFR Part 800.16(d) as the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist (36 CFR Part 800). The APE is influenced by the scale and nature of an undertaking, and it may be different for different types of effects caused by the undertaking.

The APE for the Ross Project area would include all lands where construction, operation, aquifer restoration, and decommissioning activities are proposed. This would include associated staging areas and new access roads in addition to the actual footprint of ground disturbance. In addition, the APE for the Ross Project would need to take into account additional areas where potential effects to traditional cultural properties (TCPs) are identified.

3.9.3.1 Culturally Significant Locations

No Native American heritage, special interest, or sacred sites have been formally identified or recorded to date that are directly associated with the Ross Project area. The geographic position of the Project area between mountains considered sacred by various Native American cultures (the Big Horn Mountains to the west, the Black Hills and Devils Tower to the east), however, creates the possibility that existing, specific locations could have special religious or sacred significance to Native American groups.

3.9.3.2 Tribal Consultation

According to Executive Order (EO) No. 13175, *Consultation and Coordination with Indian Tribal Governments*, the NRC is encouraged to "promote government-to-government consultation and coordination with Federally-recognized Tribes that have a known or potential interest in existing licensed uranium-recovery facilities or applications for new facilities" (NRC, 2009b). Although the NRC, as an independent regulatory agency, is explicitly exempt from the Order, NRC remains committed to its spirit. The agency has demonstrated a commitment to achieving the Order's objectives by implementing a case-by-case approach to interactions with Native American Tribes. NRC's case-by-case approach allows both NRC and the Tribes to initiate outreach and communication with one another.

As part of its obligations under Section 106 of the NHPA and the regulations at 36 CFR 800.2(c)(2)(B)(ii)(A), the NRC must provide Native American Tribes "a reasonable opportunity to identify its concerns about historic properties, advise on the identification and evaluation of historic properties and evaluation of historic properties, including those of religious and cultural importance, articulate its views on the undertaking's effects on such properties, and participate in the resolution of adverse effects." Tribes that have been identified as potentially having concerns about actions in the Powder River Basin include the Assiniboine and Lakota (Montana), Blackfoot, Blood (Canada), Crow, Cheyenne River Lakota, Crow Creek Lakota, Devil's Lake Lakota, Eastern Shoshone, Flandreau Santee Dakota, Kootenai and Salish, Lower Brule Lakota, Northern Arapaho, Northern Cheyenne, Oglala Lakota, Pigeon (Canada), Rosebud Lakota, Sisseton-Wahpeton Dakota, Southern Arapaho, Southern Cheyenne, Standing Rock Lakota, Three Affiliated Tribes, Turtle Mountain Chippewa, and Yankton Dakota (NPS, 2010). On February 9, 2011, the NRC staff formally invited 24 Tribes (see SEIS Section 1.7.3.2) to participate in the Section 106 consultation process for the proposed Ross Project. The NRC staff invited the Tribes to participate as consulting parties in the NHPA Section 106 process and sought their assistance in identifying Tribal historic sites and cultural resources that may be affected by the proposed action.

SEIS Section 1.7.3.2 describes in detail the consultation activities undertaken by NRC with Tribal governments. At this time, the NRC staff is coordinating with interested Tribes to conduct a survey of the Ross Project area to identify sites of religious and cultural significance to Tribes. Correspondence and other documents related to the NRC's Section 106 Tribal consultation efforts are listed in Appendix A.

Table 3.18 Historic and Cultural Properties Identified within the Ross Project Area		
Smithsonian Number	**Preliminary NRHP Eligibility Recommendation[a]**	**Cultural Affiliation/Site Type**
48CK1603	Eligible	Prehistoric campsite
48CK2070	Not eligible	Prehistoric artifact and possible stone ring
48CK2071	Not eligible	Prehistoric campsite
48CK2072	Not eligible	Late prehistoric campsite
48CK2073	Eligible	Prehistoric campsite
48CK2074	Not eligible	Prehistoric campsite
48CK2075	Eligible	Unknown prehistoric camp site
48CK2076	Eligible	Prehistoric stone feature; Historic cans
48CK2077	Not eligible	Prehistoric campsite
48CK2078	Eligible	Unknown prehistoric camp site; historic debris
48CK2079	Eligible	Unknown prehistoric camp site
48CK2080	Eligible	Unknown prehistoric camp site
48CK2081	Eligible	Unknown prehistoric camp site
48CK2082	Eligible	Unknown prehistoric camp site
48CK2083	Eligible	Late Archaic Prehistoric campsite
48CK2084	Not eligible	Prehistoric campsite
48CK2085	Eligible	Unknown prehistoric camp site
48CK2086	Not eligible	Prehistoric campsite
48CK2087	Not eligible	Unknown cairn
48CK2088	Not eligible	Historic homestead (Maros Homestead)
48CK2089	Eligible	Prehistoric campsite

Table 3.18
Historic and Cultural Properties Identified within the Ross Project Area (Continued)

Smithsonian Number	Preliminary NRHP Eligibility Recommendation[a]	Cultural Affiliation/Site Type
48CK2090	Eligible	Unknown prehistoric camp
48CK2091	Eligible	Middle Archaic camp
48CK2092	Eligible	Unknown prehistoric camp
48CK2093	Not eligible	Prehistoric lithic scatter

[a] The eligibility recommendations reflected in this table are those provided by the Applicant's consultant as reflected in the Class III survey report. However, the NRC staff's review of the Applicant's eligibility recommendations for the identified sites is ongoing. Therefore, for the purposes of this NEPA document, those sites that the applicant has recommended as not eligible will be treated as eligible.

3.10 Visual and Scenic Resources

What are the objectives for the visual resource classes?

Class I: To preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.

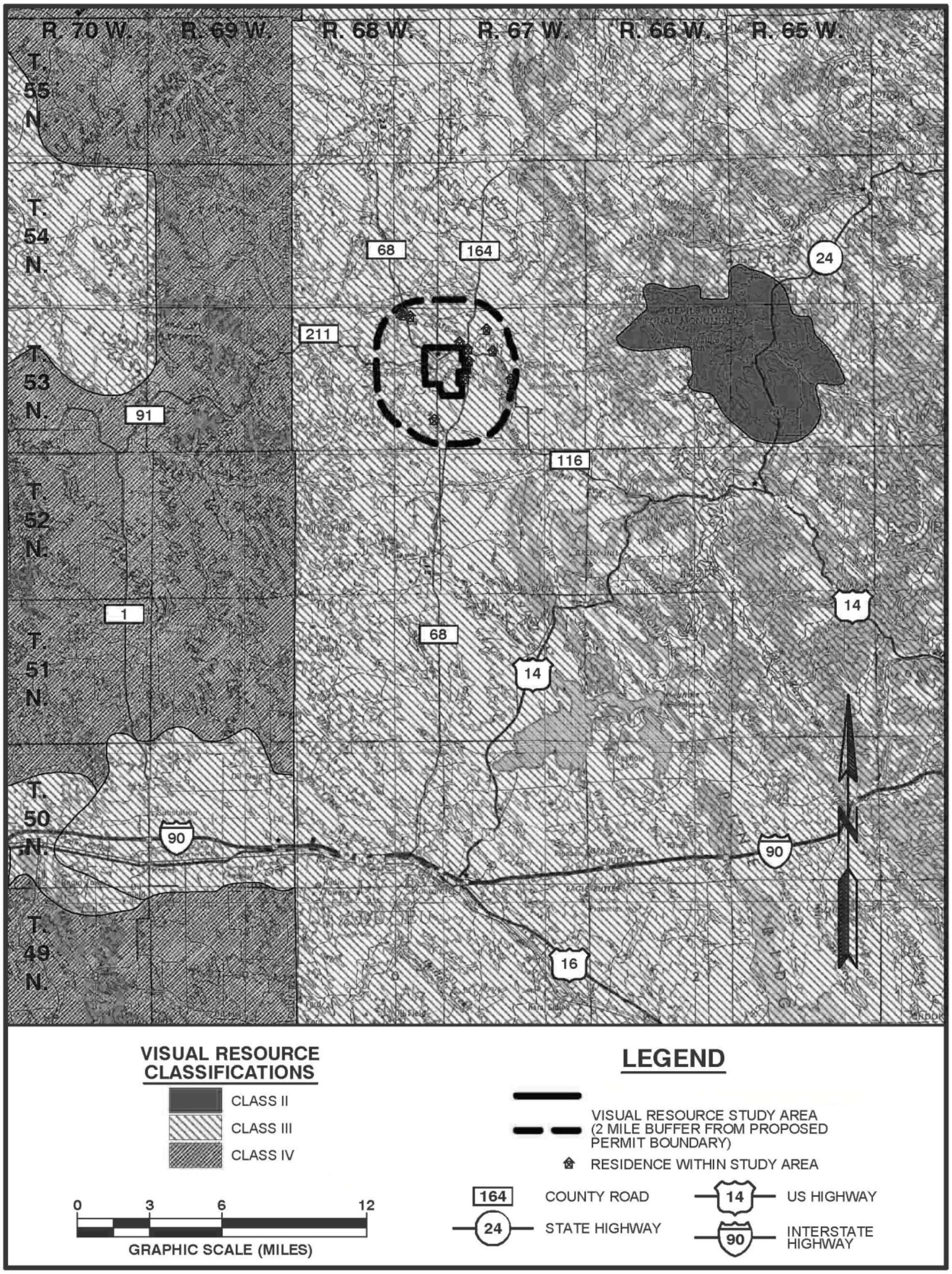
Class II: To retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

Class III: To retain partially the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

Class IV: To provide for management activities that require major modifications of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

The Ross Project area is located in a landscape of gently rolling topography and large, open expanses of upland grassland, pasture- and haylands, sagebrush shrubland, and intermittent riparian drainages. Intermittent streams are fed by ephemeral drainages that seasonally drain the adjacent uplands. A mountainous landscape east of the Ross Project can be seen; this landscape includes Devils Tower and the Missouri Buttes.

To quantify visual and scenic resources on the land it administers, the BLM has established an evaluation methodology that defines the visual and scenic quality of land through a Visual Resource Inventory (VRI). The VRI process provides a means for determining visual values. The VRI consists of a scenic-quality evaluation, sensitivity-level analysis, and a delineation of distance zones. Based on these three factors, BLM-administered lands are placed into one of four VRI classes.



Source: BLM, 2000; BLM, 2001.

Figure 3.19

Regional Visual Resources Management Classifications

These classes represent the relative value of the visual resources.

Classes I and II are designated as the most valued, Class III represents a moderate value, and in Class IV, visual resources are of the least value. The VRI classes provide the basis to assess visual values during the resource management planning (RMP) process conducted for all BLM-administered lands (see Figure 3.19) (BLM, 2010b). The VRI classes are considered in addition to other land uses, such as livestock grazing, recreational pursuits, and energy development when the BLM establishes its Visual Resource Management (VRM) classes during the RMP process. All public lands must be placed into one of the four VRM classes. VRM classes may or may not reflect the VRI classes, depending upon other resource considerations (i.e., a VRI Class II area could be managed as a VRM Class III, or vice versa). The text box above describes the VRM classes and the BLM objectives for each visual classification (BLM, 2007c).

The regional visual and scenic resources in the vicinity of the Ross Project area are described below, and the following section describes Ross Project-specific visual and scenic resources.

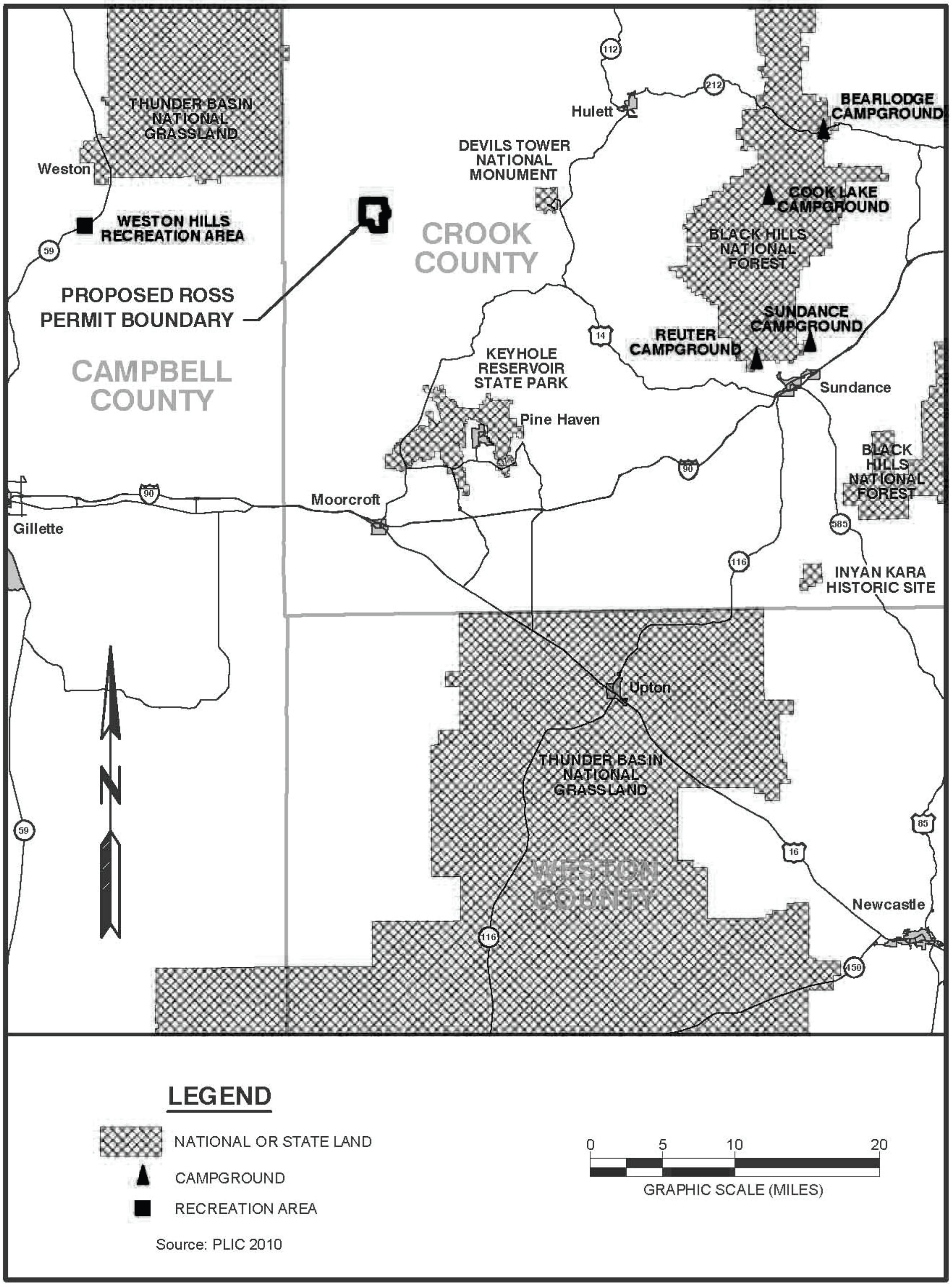
3.10.1 Regional Visual and Scenic Resources

The NSDWUMR is located within the Great Plains physiographic province, adjacent to the southern end of the Black Hills (NRC, 2009b). The northeastern corner of Wyoming, within which the Ross Project is located, is managed by the BLM's Newcastle Field Office. Most of the surrounding area is categorized as VRM Class III, but there are some Class II areas located around Devils Tower and the Black Hills National Forest, along the Wyoming-South Dakota border (see Figure 3.19).

Five areas of visually managed land are located within 32.2 km [20 m] of the Ross Project area, including Devils Tower (16 km [10 mi]) and the Missouri Buttes to the east of the Ross Project. Thunder Basin National Grassland (9.10 km [6 mi]) to the west and south, Keyhole State Park (18 km [11 mi]) to the southeast, and Black Hills National Forest (64 km [40 mi]) to the east (Strata, 2011a). These monuments, parks, and forests in the general vicinity of the Ross Project are indicated in Figure 3.20 (Strata, 2011a).

President Theodore Roosevelt established Devils Tower as a national monument on September 24, 1906. The Monument rises 386 m [1,267 ft] above the Belle Fourche River and is visible for at least 16 km [10 mi], as it is visible from the Ross Project area. Devils Tower and the surrounding countryside of pine forest, woodlands, and grassland attract visitors from around the world. The 545-ha [1,350-ac] park allows climbing, hiking, backpacking, and picnicking. Recreational climbing at Devils Tower has increased significantly in recent years. In 1973, there were approximately 312 climbers; currently, there are approximately 5,000 to 6,000 climbers a year (NPS, 2008). As noted above, the BLM VRM classification for Devils Tower is Class II. Beginning in 1995, climbers have enacted a voluntary closure, or a "no climbing period," for the entire month of June as an act of respect for Native American cultural values (NPS, 2008) (see SEIS Section 3.9.1.2).

The Black Hills National Forest (VRM Class II) encompasses streams, lakes, reservoirs, canyons and gulches, caves, varied topography, and vegetation, all of which provide habitat for an abundance of wildlife (Strata, 2011a). Keyhole State Park (VRM Class III) is home to a variety of wildlife. Keyhole Reservoir is the primary attraction to the Park and provides visitors



Source: PLIC, 2010,
as shown in Strata, 2012a.

Figure 3.20

Roads, National Parks, National Monuments, and Forests in Vicinity of Ross Project Area

many recreational opportunities including fishing, camping, and hiking (Strata, 2011a). The Thunder Basin National Grassland (VRM Class IV) also provides many opportunities for recreation, including fishing, hiking, and bicycling. Lush, green pastures at the Grassland provide abundant wildlife habitat. The U.S. Forest Service (USFS) manages the Grassland to conserve the natural resources of grass, water, and wildlife habitats (Strata, 2011a).

3.10.2 Ross Project Visual and Scenic Resources

The Applicant conducted a site-specific scenic-quality inventory and evaluation of the Ross Project area in October 2010, using the BLM VRI methodology (see Figure 24) (BLM, 2010b). The scenic-quality evaluation for the visual-resource study area was evaluated based on the key factors of landform, vegetation, water, color, influence of adjacent scenery, scarcity, and cultural modifications. The average scenic-quality index for the Ross Project area was determined by a rating of the scenic quality of four individual aspects (the cardinal compass points) viewed from a high point in the center of the Ross Project. The individual scores were averaged to get a scenic-quality score for the entire Ross Project area. The scenic-quality evaluation presented in Table 3.19 shows that the visual-resource evaluation rating calculated for the Ross Project area is a 10.5 out of a possible 32. More detailed information on the Ross Project scenic-quality inventory and evaluation, including photos, can be found in Appendix B.

Table 3.19
Scenic-Quality
Inventory and Evaluation
(Arithmetic Average of Four Views)

Key Factor	Score
Landform	2.00
Vegetation	3.00
Water	0.50
Color	2.50
Influence of Adjacent Scenery	1.25
Scarcity	2.00
Cultural Modifications	-0.75
TOTAL	**10.50**

The BLM VRM classifications for the lands within and near the Ross Project area are shown on Figure 3.19 (BLM, 2000; BLM, 2001). The land west of the Ross Project is located in Campbell County and is categorized as VRM Class IV, while the land surrounding the Ross Project in Crook County to the east is categorized as VRM Class III. The areas studied for visual resources include the Ross Project and the 3.2-km [2-mi] surrounding vicinity. Thus, this visual-resources area is located entirely within Crook County, and it is consequently categorized as VRM Class III. The level of change allowed by the BLM to the characteristic landscape in Class III management areas would be moderate (BLM, 2010b).

No developed parks or recreational areas are located within the Ross Project and the 3.2-km [2-mi] area around the Project (Strata, 2011a). Within these areas, there are 11 residences in addition to storage tanks; pump jacks; small maintenance buildings; public and private roads and road signage; utilities and poles (power and other utility lines); agricultural features (fences, livestock, stock tanks, and cultivated fields), and environmental-monitoring installations are prominent in the immediate foreground, and they are often noticeable in foreground views by the casual observer.

Of the 11 residences within the study area, 4 residences have unobstructed views to the Ross Project area where the uranium-recovery facility and wellfields would be constructed, and they are in close proximity to the Ross Project in general. The closest residence is 210 m [690 ft] from the Project boundary. Of the 11 residences, 8 are located to the east of the Project area with views to the east (e.g., Devils Tower) and 3 of the 11 residences are northwest of the Ross Project area. Figure 3.21 indicates the areas where the Ross Project facility (i.e., CPP and surface impoundments) would be visible, and Figure 3.22 indicates the potential areas where light pollution from the Ross Project could impact. Photographs used to document the visual-resource study are included in Appendix B.

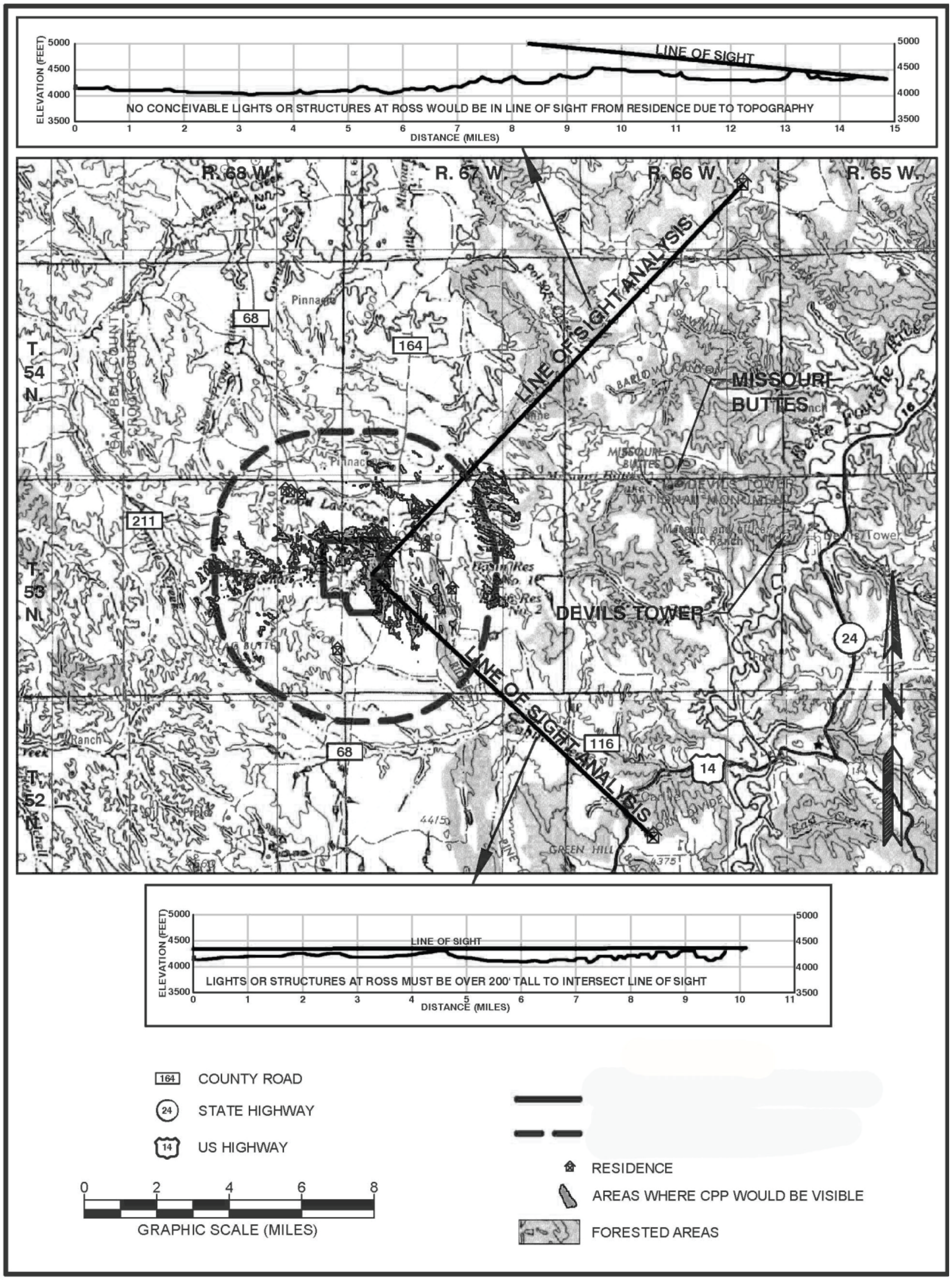
3.11 Socioeconomics

The Ross Project's region of influence (ROI) is defined as the area within which the Ross Project's socioeconomic impacts and benefits are reasonably anticipated to be concentrated. The Ross Project would be located in Crook County, but it is close enough to the Campbell County line that both counties are within this area of potential impacts. The ROI extends approximately 57 miles to the eastern boundary of Crook County, 41 miles to the northern boundary of Crook County, 115 miles to the western boundary of Campbell County, and 121 miles to the southern boundary of Campbell County. The ROI includes all of the towns and unincorporated areas within Crook County, in which the Project's facility and wellfields would be located and, therefore, would benefit from mineral-production tax revenues. It also includes adjacent Campbell County, which hosts the nearest, largest urban area (i.e., Gillette) and is, consequently, a potential source of labor, services, and materials to support the Ross Project.

3.11.1 Demographics

In Campbell County, Gillette, Wyoming, is the nearest urban area to the Ross Project; it is approximately 53 km [33 mi] to the southwest of the Project. Gillette would likely serve as a regional logistics hub as well as a source of personnel and supplies for the Ross Project (Strata, 2011a). Moorcroft, Wyoming, is approximately 35 km [22 mi] from the Ross Project area and could be a source of personnel as well as a place of residence for Project staff (Strata, 2011a).

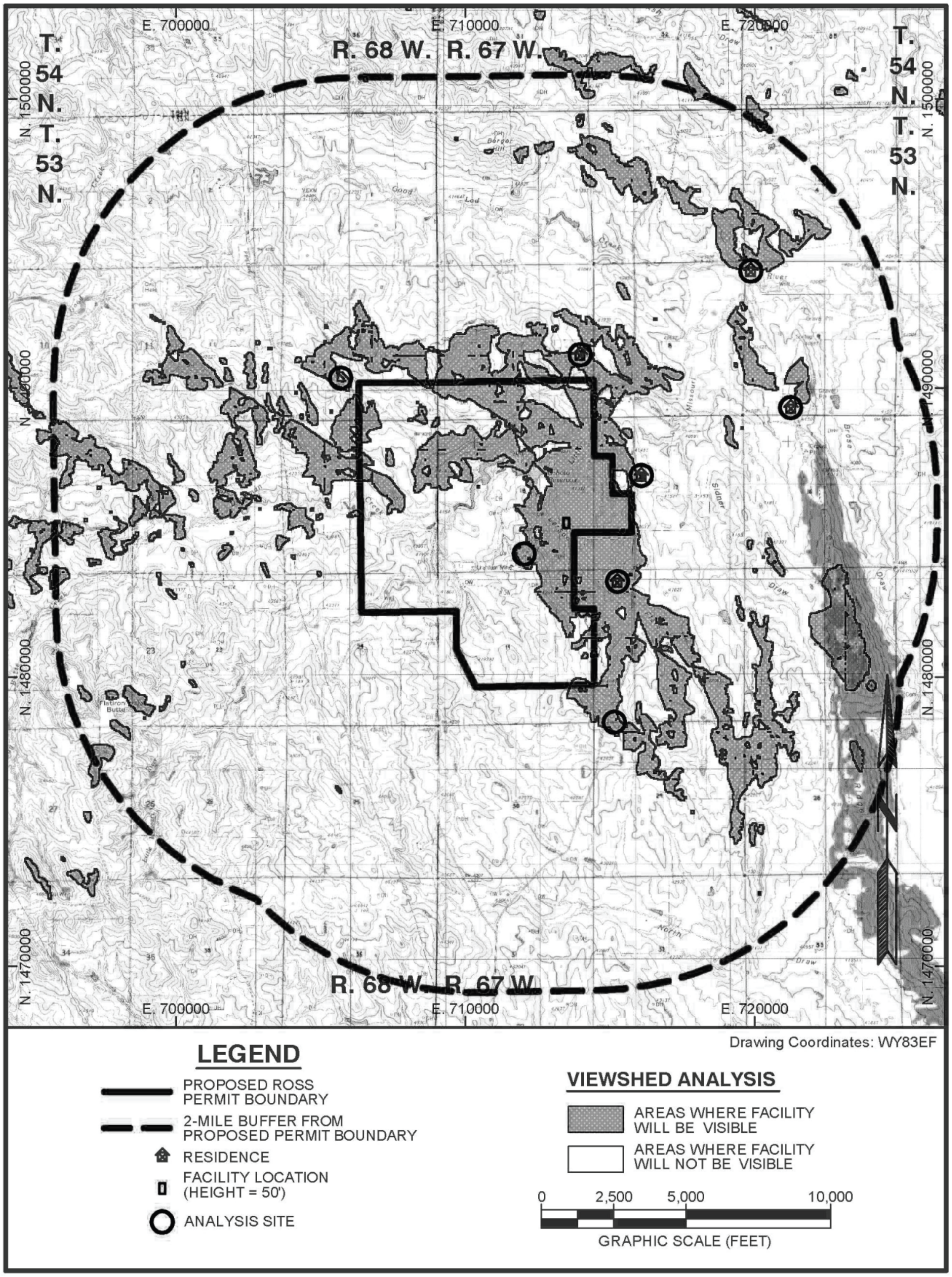
Table 3.20 presents the 2000 and 2010 population data for the potentially affected jurisdictions in the ROI. The population in Crook County was 7,083 persons as of 2010, having increased 20.3 percent over 2000 levels (USCB, 2012). The population in Campbell County was 46,133



Source: Strata, 2012a.

Figure 3.21

Viewshed Analysis of Ross Project Area



Source: Strata, 2012a.

Note: Prior to construction of the Ross Project, baseline monitoring for potential light pollution would be conducted at eight sites.

Figure 3.22

Light-Pollution Study Area

persons as of 2010, having increased 36.9 percent over 2000 levels. In contrast, population of Wyoming as a whole increased only 14.1 percent between 2000 and 2010. Crook County is the third least populous county in Wyoming, whereas Campbell County is the third most populous.

Table 3.20
Populations in Crook County, Campbell County, and Wyoming
2000 and 2010

Jurisdiction	2000	2010	Change	Total Change (percent)	Annual Average Change (percent)
Crook County	5,887	7,083	1,196	20.3%	1.9%
Hulett	408	383	-25	-6.1%	-0.6%
Moorcroft	807	1,009	202	25.0%	2.3%
Pine Haven	222	490	268	120.7%	8.2%
Sundance	1,161	1,182	21	1.8%	0.2%
Campbell County	33,698	46,133	12,435	36.9%	3.2%
Gillette	19,646	29,087	9,441	48.1%	4.0%
Wright	1,347	1,807	460	34.1%	3.0%
TOTAL ROI	39,585	53,216	13,631	34.4%	3.0%
TOTAL WYOMING	493,782	563,626	69,844	14.1%	1.3%

Source: USCB, 2012

Between 2000 and 2010, Gillette grew by 48.1 percent, faster than the county as whole and much faster than the entire State. This is largely attributable to the growth in the energy sector, conventional oil and gas, coal mining, and power plant construction.

The population of Campbell County is younger than the Wyoming average, has more people per household, more households with individuals under 18 years of age, fewer households with individuals over 65 years of age, and slightly more female householders with no husband present and with their own children under 18 years old (USCB, 2012). Conversely, the population of Crook County is older than the Wyoming average with a higher median age, smaller percentage of households with individuals under 18 years of age, and a higher percentage of households with persons 65 years of age or older.

3.11.2 Income

Per capita personal income in Crook County was $45,843 per person in 2009 and was $49,986 per person in Campbell County (USBEA, 2011). By comparison, per capita income in Wyoming was $49,887 and $40,936 in the U.S. (USBEA, 2011). Based upon the population characteristics discussed above, total personal income in the two-county area was $2.6 billion. Per capita income in Crook and Campbell counties grew at an average annual rate of 3.9 percent over the 2000 to 2009 period (USBEA, 2011). In contrast, per capita income in Wyoming grew at a slightly lower rate of 3.4 percent per year, while the rate of growth in the U.S. over the same period was only 0.8 percent.

Average earnings per job in Crook County were $35,371 in 2009, having increased 2.9 percent annually since 2000. Average earnings per job in Campbell County are almost twice as high as in Crook County and were $64,612 in 2009, having increased 2.9 percent annually since 2000. In contrast, earnings per job State-wide were $46,831 and $52,358 in the U.S. for the same period.

3.11.3 Housing

As of 2010, there were 18,955 housing units in Campbell County (USCB, 2012). Of these, 1,783 were vacant housing units, representing an overall vacancy rate of 9.4 percent (USCB 2012). Of the 1,783 vacant units, 689 of the vacant units were for rent. In contrast, there were only 3,595 housing units in Crook County in 2010. Of these, 674 were vacant housing units, for an overall vacancy rate of 18.7 percent. Of the vacant units, only 54 vacant units were for rent.

Homeownership rates in the two Counties are high by state and national standards. Owner-occupied units accounted for 73.3 percent of all occupied units in Campbell County and 79.3 percent of all occupied units in Crook County (USCB, 2012). Homeownership for the State is 69.2 percent of the population, compared to the entire U.S. where homeownership is 65.1 percent of the population.

3.11.4 Employment Structure

Wyoming State Data

In October 2009, the seasonally-adjusted unemployment rate in Wyoming reached 7.4 percent for the first time since September 1987. Unemployment rates have been on the decline since that time, with the August 2011 rate reported at 5.5 percent (BLS, 2011; WDWS, 2011a).

State-wide employment grew 6.5 percent between the years 2000 and 2010 and stood at 273,313 employed persons in 2010 (WDWS, 2011a). By August 2011, employment was 296,424 persons, up from 277,625 persons in August 2010.

Trade, transportation, and utilities employment represent the largest employment sector in Wyoming, with 24.0 percent of employed persons as of 2010 (WDWS, 2011a), comparable to the U.S. average of 23.0 percent. State-wide employment in the natural resources and mining sector amounted to 13.4 percent of all employment, significantly higher than the U.S. average of 1.7 percent.

Crook and Campbell County Data

Employment in Crook County over the past decade has typically been in the 3,000 to 3,400 range, with peak employment registered at 3,404 persons in 2008 (WDWS, 2011a). Average annual employment in 2010 was 3,284 persons. The August 2011 monthly level is currently at 3,475 persons, down slightly from the August 2010 level of 3,527 persons. Unemployment rates in Crook County have been typically low by national standards, ranging from 2.7 percent to 4.3 percent over the 2000 to 2007 period, but subsequently rose to 5.8 percent in both 2009 and 2010 (BLS, 2011). The unemployment rate as of August 2011 stood at a slightly reduced level of 5.0 percent, representing 175 unemployed persons at this time.

In contrast to Crook County, employment in Campbell County over the past decade has typically been in the 20,000 to 28,000 range, with peak employment registered at 28,492 persons in 2009 (WDWS, 2011a). Employment dropped slightly in 2010 to 27,531 persons and August 2011 levels are currently at 25,542 persons, up slightly from the comparable period in 2010, but still down from 2010 averages.

Unemployment rates in Campbell County also have been typically low by national standards, ranging from 2.0 percent to 3.7 percent over the 2000 to 2008 period, but subsequently rose to 5.5 percent in 2009 and 6.0 percent in 2010 (BLS, 2011). The unemployment rate as of August 2011 stood at a reduced level of 4.4 percent, representing 11,166 unemployed persons at this time.

3.11.5 Finance

The State of Wyoming does not levy a personal or corporate income tax, nor does Wyoming impose a tax on intangible assets such as bank accounts, stocks, or bonds (Strata, 2011a). In addition, Wyoming does not assess any tax on retirement income earned and received from another state. Revenues to the State of Wyoming come from three sources: taxes on mineral production, earnings on investments, and general-fund revenues. Taxes on mineral production include property taxes on the assessed value of production, severance taxes, royalties on production of State-owned minerals, and the State's share of Federal mineral royalties. General-fund revenues include sales (at 4 percent) and use taxes, charges for sales and services, franchise taxes, and cigarette taxes. The third source of State revenues is earnings from the Wyoming Permanent Mineral Trust Fund and pooled investments.

Cities and counties receive revenues in the form of property taxes as well as local sales and use taxes up to 2 percent, including special assessments such as capital-facilities taxes and revenue sharing from the State. Local governments are responsible for collection of property taxes, which are the primary source of funding for public schools and for municipalities, counties, and other local government units. Although Crook County has a slightly higher average mill levy than Campbell County, the mill levy is applied to a much lower evaluation, thus the property taxes raised in Crook County amounted to only a little more than 4 percent of those raised in Campbell County in FY 2010 (Strata, 2011a).

3.11.6 Education

Kindergarten through 12th grade (K-12) public schools in Wyoming are generally organized at the county or sub-county level by school district. Campbell and Crook counties each have one public school district. Campbell County School District operates 16 elementary schools, 2 junior high schools, 2 high schools, and 1 combined junior/high school (Strata, 2011a). Crook County operates a single K-12 school, 2 elementary schools, 2 secondary (grades 7-12) schools, and 1 high school (grades 8-12).

Campbell County has higher school attendance rates than Wyoming as a whole in all grade levels, except college or graduate school (Strata, 2011a). The student-teacher ratio is 19.6 to 1 (Campbell County School District, 2012). Crook County is below the State average at the nursery and preschool ages as well as at the kindergarten and college/graduate school levels, but well above the State average at the elementary (grades 1 – 8) and high-school levels. The student-teacher ratio is 11 to 1 (Education.com, Inc., 2012).

Wyoming also has seven community-college districts. The Northern Wyoming Community College District consists of the main campus in Sheridan, a satellite campus in Gillette, and outreach centers in Buffalo, Kaycee, and Wright. The Gillette campus is the closest post-secondary school to the Ross Project area (Strata, 2011a).

3.11.7 Health and Social Services

Campbell County Memorial Hospital is the principal health-care provider in northeast Wyoming and offers a full range of health services, including emergency room and outpatient surgery services (Strata, 2011a). It is located approximately 65 miles from the Ross Project area. The Heptner Radiation Oncology Center was completed in 2002, and an expansion of medical oncology services was completed in 2008 to form the Cancer Care Center at Campbell County Memorial Hospital. An approximately 560 m^2 [6,000-ft^2] expansion of the Emergency Department was completed in 2009 and an extensive laboratory was completed in late 2009. The laboratory project included the first full chemistry automation line in Wyoming. A $68-million expansion project on the Hospital began in June 2009, with construction of a 3.5 level, 294-space parking structure adjacent to the main entrance of the Hospital. Construction began on a three-level Hospital addition, capable of supporting three additional levels, in 2010. In addition to the Hospital, Campbell County also has outpatient and walk-in clinics, surgery and rehabilitation centers, and numerous senior-residence facilities.

The Crook County Medical Services District consists of a hospital and clinic located in Sundance, as well as clinics located in Moorcroft and Hulett. The District also provides a long-term-care facility attached to the hospital in Sundance (Strata, 2011a).

Sundance, Moorcroft, and Hulett have an ambulance service to cover each town and surrounding areas. Each service has Emergency Medical Technician (EMT) Intermediates, EMT Basics, and Emergency Medical Responders (EMRs) serving on their teams. Of these, Moorcroft is closest to the Ross Project area.

A community survey of needs and services was published in June 2010 by the Campbell County CARE Board. The primary purpose of this needs assessment was to better understand the needs of people who are living in poverty in Campbell County. This survey showed that both low-income clients and agencies ranked, in order, the following services as the most highly rated needs of the County:

- Emergency services
- Housing
- Health

- Nutrition/food
- Employment and training

3.12 Public and Occupational Health and Safety

The existing pre-licensing baseline radiological conditions at the Ross Project area are discussed below.

3.12.1 Existing Site Conditions

As required by 10 CFR Part 40, Appendix A, Criterion 7, the Applicant has conducted one year of pre-licensing, pre-operational baseline radiological monitoring of the Ross Project area. It began its monitoring activities in August 2009. The resulting monitoring data establish the Ross Project area's baseline characteristics prior to NRC licensing. This site-characterization monitoring was developed and implemented in accordance with the following NRC guidelines:

- NRC Regulatory Guide 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills*, Revision 1 (NRC, 1980).
- NRC Regulatory Guide 3.46, *Standard Format and Content of License Applications, Including Environmental Reports, For In Situ Uranium Solution Mining*, Section 2.9 ("Radiological Background Characteristics") (NRC, 1982a).
- NRC Regulatory Guide 3.8, *Preparation of Environmental Reports for Uranium Mills* (NRC, 1982b).
- NUREG–1569, *Standard Review Plan For In Situ Leach Uranium Extraction License Applications* (NRC, 2003).

These pre-licensing baseline radiological data represent the condition of the Ross Project area prior to development or construction of any Ross Project facility, wellfields, or any other structural improvements. These data would support future assessments of any environmental impacts that could occur as a result of the Ross Project's construction, operation, and decommissioning, including accidental releases. That is, for most resource areas, the site-characterization data collected by the Applicant would be used to compare and contrast any data collected during the operation of the Ross Project as well as post-operational data collected later.

In the case of ground-water resources, however, additional post-licensing, pre-operational data would be collected (i.e., after the NRC license has been issued, but before actual uranium recovery in a wellfield is initiated, as would be required by the NRC license). This post-licensing, pre-operational data set, which would be established for each wellfield prior to uranium recovery in that wellfield, would serve as a benchmark for the Applicant to determine whether an excursion has occurred (i.e., by way of the upper control limits (UCLs) established for that particular wellfield) and whether the ground water in a wellfield has been restored to the respective target values. These further sampling and analysis activities are discussed in SEIS Sections 2.1.1.1 and 3.5.3.

As discussed in SEIS Section 3.5.3, results from ground-water site-characterization samples can be compared to the specific regulatory standards published by the EPA and the WDEQ/WQD. However, most of the analytical results discussed in this section cannot be compared easily to existing standards because the standards are specified in units other than the reported laboratory units. That is, for example, gross alpha results are reported in picoCuries/volume (pCi/L) [Bq/L] or pCi/kg [Bq/kg] (i.e., in liquid or solid matrices, respectively). This unit is a measurement of the radioactivity in a sample (such as ground water or soil). However, the units of radiation-dose standards are specified in radiation dose/unit time (Sievert or millirem [Sv or mrem]/unit time), and pCi/L or pCi/kg concentrations cannot be straightforwardly converted to mrem/unit time, which is a standard for a human's radiation dose, without extensive modeling (including the conversion to a Total Effective Dose Equivalent [TEDE] which is one of the units used in radiation-protection regulations) (see SEIS Section 4.13). The NRC staff has taken the pre-licensing baseline data supplied by the Applicant and reviewed the modeling that the Applicant performed to determine the respective total radiation dose currently present at the Ross Project area, given the radioactivity-concentration values included in Strata's license application (Strata, 2011b; Strata, 2012b). The modeling and the pre-operational monitoring results performed by the Applicant indicate that the existing conditions at the Ross Project area do not exceed any radiation-dose guidelines or standards in the applicable regulations.

How are potential radiation exposures and doses calculated?

Radiation dose estimates are quantified in units of either **Sievert** or **rem** and are often referred to in either milliSievert (mSv) or millirem (mrem) where 1,000 mSv = 1 Sv and 1,000 mrem = 1 rem (Sv = 100 rem). These units are used in radiation protection to quantify the amount of damage to human tissue expected from a dose of ionizing radiation.

Person-Sv (or person-rem) is a metric used to quantify population radiation dose (also referred to as collective dose). It represents the sum of all estimated doses received by each individual in a population and is commonly used in calculations to estimate latent cancer fatalities in a population exposed to radiation.

Radiation dose is a measure of the amount of ionizing energy that is deposited in a human body. Ionizing radiation is a natural component of the environment and ecosystem, and members of the public are exposed to natural radiation continuously. Radiation doses to the general public occur as a result of the radioactive materials found in the Earth's soils, rocks, and minerals (including those in the Ross Project area). For example, radon-222 (Ra-222) is a radioactive gas that escapes into ambient air from the decay of uranium (and its progeny radium-226), which is found in most soils and rocks. Naturally occurring low levels of uranium and radium are also found in drinking water and foods. Cosmic radiation from space is another natural source of radiation. In addition to these natural sources, there are also artificial or human-made sources that contribute to the radiation dose the general public routinely receives. For example, medical diagnostic procedures using radioactive materials and x-rays are the primary human-made source of radiation the general public experiences. For comparison, the National Council for Radiation Protection estimates the average dose to the public from all natural radiation sources (terrestrial and cosmic) is 3.1 millisieverts (mSv) [310 millirem (mrem)] per year. In Wyoming, this figure is approximately 3.15 mSv/year [316 mrem/yr] (NRC, 2009b).

Pre-Licensing Baseline Radiological Conditions

Table 3.21 presents the range (i.e., the minimum and maximum values) of selected pre-licensing baseline data for the some of the radiological parameters required by the NRC's Regulatory Guide 4.14 (Strata, 2011b; NRC, 1980). Individual reported values for the various radiological parameters can be found in the Applicant's TR (Strata, 2011b).

Pre-Licensing Baseline Sample Matrices, Locations, and Results

The Applicant's pre-licensing baseline environmental-monitoring program was conducted under rigorous sampling-and-analysis procedures and quality-control methods (Strata, 2011b). During the Applicant's environmental monitoring efforts, local ground and surface waters were sampled and analyzed as were samples of sediments, vegetation, air, wildlife, and fish. Direct gamma ("γ") radiation was also measured. The pre-licensing baseline monitoring program included the Applicant's obtaining samples of the following matrices at the specified locations and having the samples analyzed for the radiological parameters shown in Table 3.21. The range of the values obtained by laboratory analysis of these samples is presented in Table 3.21 as well.

Surface Water

The surface waters at the Ross Site were sampled by the Applicant at 14 locations. These locations included both the Oshoto Reservoir and two creek samples (one each from Deadman Creek and the Little Missouri River) during June 2010. Ten other water reservoirs in the Lance District were sampled as well. Three locations on the Ross Site are set up to automatically collect samples during any significant runoff events, although none occurred during the monitoring period (Strata, 2011b). In addition, intermittent and ephemeral surface-water channels were sampled when water was present. Figure 3.14 shows these locations.

Ground Water

Ground-water samples were collected during the Applicant's pre-licensing baseline site-characterization efforts at the Ross Project area. The samples were collected at six locations within the Ross Project area using monitoring wells screened from various horizons within the Lance/Fox Hills aquifer, on-site and nearby privately owned water supply wells. The results of all ground-water samples are more fully discussed in SEIS Section 3.5.3. Note that for samples where metals, including uranium, were to be analyzed, these samples were filtered, yielding "dissolved" concentrations in the data reported. This methodology is described in SEIS Section 3.5.3.

As discussed in the Applicant's license application and in SEIS Section 3.5.3, several ground-water samples exceeded radiological criteria specified by the EPA for its MCLs, and some exceeded more than one of the criteria. The three MCLs are:

- Uranium = 30 μg/L
- Radium-226+228 = 5 pCi/L [0.19 Bq/L]
- Gross Alpha = 15 pCi/L [0.56 Bq/L]

Table 3.21 Range of Analytical Results of Pre-Licensing Baseline Samples* All Sample Matrices					
Matrix	Type	Selected Parameters	Range (If Any) of Results** (Minimum to Maximum)	Units	Any Samples Greater than Detection Limit?
Water					
	Surface Water[†,††]				
		Lead-210	<1 – 1.46	pCi/L	Yes
		Polonium-210	<1**	pCi/L	No
		Radium-226	<0.02 – 0.46	pCi/L	Yes
		Radium-228	<1 – 1.52	pCi/L	Yes
		Thorium-230	<0.2	pCi/L	No
		Uranium[a]	<0.001 – 0.089	mg/L	Yes
		Gross Alpha	<2 – 48.7	pCi/L	Yes
	Ground Water[†,††]				
		SA Zone			
		Lead-210	<1	pCi/L	No
		Polonium-210	<1	pCi/L	No
		Radium-226	<0.2 – 0.5	pCi/L	Yes
		Radium-228	<0.1 – 1.8	pCi/L	Yes
		Uranium	<0.001 – 0.007	mg/L	Yes
		Gross Alpha	<6 – 13.8	pCi/L	Yes
		SM Zone			
		Lead-210	<1 – 1.34	pCi/L	Yes
		Polonium-210	<1	pCi/L	No
		Radium-226	<0.2 – 3.7	pCi/L	Yes
		Radium-228	<0.1 – 1.3	pCi/L	Yes
		Uranium	<0.001 – 0.004	mg/L	Yes
		Gross Alpha	<7 – 12.2	pCi/L	Yes
		Ore Zone			
		Lead-210	<1 – 4.89	pCi/L	Yes
		Polonium-210	<1 – 22.9	pCi/L	Yes
		Radium-226	0.6 – 12.1	pCi/L	Yes
		Radium-228	<0.1 – 1.4	pCi/L	Yes
		Uranium	0.005 – 0.109	mg/L	Yes
		Gross Alpha	<5 – 222	pCi/L	Yes

Table 3.21
Range of Analytical Results of Pre-Licensing Baseline Samples*
All Sample Matrices
(*Continued*)

Matrix	Type	Selected Parameters	Range (If Any) of Results** (Minimum to Maximum)	Units	Any Samples Greater than Detection Limit?
		DM Zone			
		Lead-210	<1 – 1.16	pCi/L	Yes
		Polonium-210	<1	pCi/L	No
		Radium-226	<0.2 – 0.7	pCi/L	Yes
		Radium-228	<0.1 – 2.2	pCi/L	Yes
		Uranium	<0.001 – 0.013	mg/L	Yes
		Gross Alpha	<14 – 28.3	pCi/L	Yes
	Piezometers in SA Zone				
		Lead-210	<1	pCi/L	No
		Polonium-210	<1	pCi/L	No
		Radium-226	<0.2 – 0.53	pCi/L	Yes
		Radium-228	<0.01 – 2.5	pCi/L	Yes
		Uranium	<0.01 – 0.264	mg/L	Yes
		Gross Alpha	<8.44 – 218	pCi/L	Yes
Soil					
	Surface and Subsurface Soils				
		Lead-210	<0.2 – 2.0 ± 0.7	pCi/g	Yes
		Radium-226	<0.005 – 14.4 ± 2.0	pCi/g	Yes
		Thorium-230	<0.2 – 1.29 ± 0.59	pCi/g	Yes
		Uranium	<0.01 – 2.80	mg/kg	Yes
		Gross Alpha	<1 – 3.6 ± 1.7	pCi/g	Yes
	Sediments				
		Lead-210	<1 – 471 ± 6.1	pCi/g	Yes
		Radium-226	0.8 ± 0.1 – 1.5 ± 0.1	pCi/g	Yes
		Thorium-230	0.39 ± 0.14 – 371 ± 58	pCi/g	Yes
		Uranium	0.876 – 2.24	mg/kg	Yes
		Gross Alpha	1.1 ± 0.4 - 2.8 ± 0.6	pCi/g	Yes

Table 3.21
Range of Analytical Results of Pre-Licensing Baseline Samples*
All Sample Matrices
(*Continued*)

Matrix	Type	Selected Parameters	Range (If Any) of Results** (Minimum to Maximum)	Units	Any Samples Greater than Detection Limit?
Air					
	Particulates				
		Lead-210	6.25×10^{-8} – 1.14×10^{-5}	pCi/L	Yes
		Radium-226	<Detection Limits[d]	pCi/L	No
		Thorium-230	<Detection Limits – 9.74×10^{-8}	pCi/L	Yes
		Uranium	<1.16×10^{-8} – 9.41×10^{-9}	pCi/L	Yes
	Radon				
		Average Radon[b]	0.3 ± 0.04 – 2.0 ± 0.13	pCi/L	Yes
Vegetation					
	Grazing Vegetation				
		Lead-210	3.9 ± 0.5 – 264 ± 19.1	pCi/L	
		Polonium-210	0.225 ± 0.51 – 23.4 ± 7.2	pCi/L	
		Radium-226	1.12 ± 0.08 – 1,530 ± 0.4	pCi/L	
		Thorium-230	<0.2 – 89.5 ± 16.4	pCi/L	
		Uranium	0.0017 – 8.99	mg/kg	
	Wetland Vegetation				
		Lead-210	9.07 ± 4.1 – 43.1 ± 6.1	pCi/L	
		Polonium-210	1.87 ± 1.7 – 5.88 ± 2.8	pCi/L	
		Radium-226	0.3 ± 0.1 – 11.4 ± 0.5	pCi/L	
		Thorium-230	<0.2 – 3.9 ± 1.5	pCi/L	
		Uranium	0.0005 – 0.0019	mg/kg	
	Hay[c]				
		Lead-210	122 ± 13	pCi/L	
		Polonium-210	7.61 ± 4.1	pCi/L	
		Radium-226	123 ± 1.1	pCi/L	
		Thorium-230	0.83 ± 0.20	pCi/L	
		Uranium	3.10	mg/kg	

Table 3.21
Range of Analytical Results of Pre-Licensing Baseline Samples*
All Sample Matrices
(*Continued*)

Matrix	Type	Selected Parameters	Range (If Any) of Results** (Minimum to Maximum)	Units	Any Samples Greater than Detection Limit?
	Vegetable[c]				
		Lead-210	2.95 ± 4.9	pCi/L	
		Polonium-210	2.55 ± 1.8	pCi/L	
		Radium-226	<0.05	pCi/L	
		Thorium-230	0.40 ± 0.90	pCi/L	
		Uranium	0.0001	mg/kg	
Animal					
	Livestock (Beef)[c]				
		Lead-210	3.12 ± 4.8	pCi/L	
		Polonium-210	<1.0	pCi/L	
		Radium-226	0.288 ± 0.05	pCi/L	
		Thorium-230	<0.2	pCi/L	
		Uranium	<0.001	mg/kg	
	Wildlife (Deer)[c]				
		Lead-210	13.0 ± 7.5	pCi/L	
		Polonium-210	3.68 ± 3.75	pCi/L	
		Radium-226	1.8 ± 1.5	pCi/L	
		Thorium-230	7.6 ± 4.2	pCi/L	
		Uranium	<0.001	mg/kg	
	Fish[c]				
		Lead-210	60.4 ± 93.6	pCi/L	
		Polonium-210	<1.0	pCi/L	
		Radium-226	175 ± 15	pCi/L	
		Thorium-230	0.6 ± 0.6	pCi/L	
		Uranium	0.0160	mg/kg	
Direct Gamma					
	Gamma Survey		5.3 – 25.3 ± 1.54	μR/hr	
	TLD Exposure[d]		17.3 – 30.1	mrem/day	

1 Source: Strata, 2011b.
2 Notes: See next page.

Notes for Table 3.21:

* As suggested by NUREG-4.14.

** "<" = "Less than," where the value following the "<" value is the detection limit.

† Results also discussed in SEIS Sections 3.5.1 and 3.5.3, Water Quality.

†† All metals concentrations in water matrices reported as dissolved concentrations (i.e., the samples were filtered).

[a] All uranium concentrations were obtained by wet-chemistry analysis, not isotope speciation by alpha or gamma spectrometry.

[b] Averages are radon concentrations taken over three months at each monitoring station.

[c] One sample only.

[d] Averages taken from approximately three-month exposures of thermo luminescent dosimeters (TLDs) at each monitoring station. Each value is the "Environmental Dose," where the Environmental Dose is the Reported Dose (i.e., recorded by the TLD) minus the Transit Dose (i.e., dose received by TLD while in transit to laboratory).

Monitoring Wells and Piezometers

Six well clusters were used by the Applicant to sample ground water quarterly in 2010 (Strata, 2011b). An additional four piezometers in the CPP area were also used quarterly beginning in May 2010 (a piezometer is a device that measures the pressure [more precisely, the piezometric head] of ground water at a specific location.) As described in SEIS Section 2.1.1.1, the six well clusters allowed access to four different ground-water systems in the SA, SM, OZ, and DM zones.

Drinking Water Wells

Twenty-nine local drinking water wells were also sampled quarterly, beginning in July 2009. Some of these samples could not always be obtained because some of the wells were either inaccessible during winter or non-functioning (Strata, 2011b).

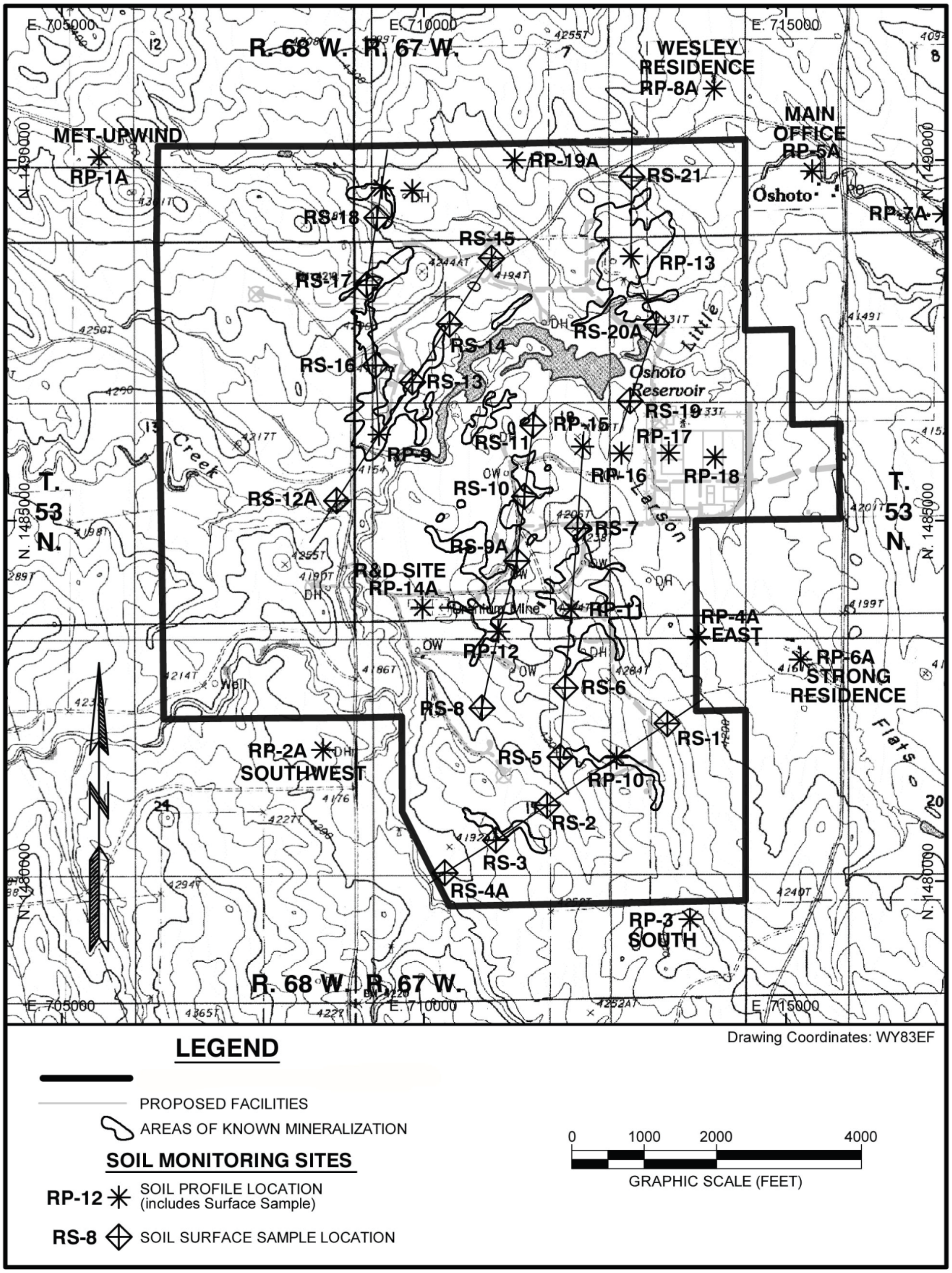
Sediments

The sediments at Oshoto Reservoir as well as those at the three surface-water monitoring stations were sampled in August 2010 (Strata, 2011b). Two cups of sediment were sampled for each location and analyzed for Uranium, Ra-226, Th-230, Pb-210, and gross alpha.

Soil

Soil samples at the Ross Project area were obtained from 39 locations; each location was sampled at three depths (i.e., 0-30, 30-60, and 60-100 cm [0-11.8, 11.8-23.6, and 23.6-39.4 in]) (Strata, 2011b). Figure 3.23 indicates the locations of soil sampling activities. These include the three nearest residences, Strata's Oshoto Field Office, the potential locations of the surface impoundments and the CPP, and locations over the major ore bodies where production and recovery wells could be located.

1



Source: Strata, 2011b.

Figure 3.23

Soil Sampling Locations at Ross Project Area

Air

Particulates

Samples of airborne particulates (e.g., dust) were collected by the Applicant at the six air-sampling stations shown in Figure 3.24. Five of these stations commenced operation in January 2010; the sixth began operating in November 2010. The filters at each air-sampling location were collected weekly and then later composited for analysis (i.e., the filters from each sampling station were composited with the filters from only that respective station, the filters having been collected weekly over an entire quarter for a total of approximately 13 filters per composite sample) (Strata, 2011b).

Radon

Seventeen radon-sampling locations were established by the Applicant, and the results at each were collected quarterly beginning in January 2010; two of these stations were established in mid-2010, resulting in fewer samples. The radon (i.e., a potential gaseous emission) samplers are situated at each of the particulate-sampling locations as well as in the proposed CPP and surface-impoundment areas, the four nearest residences, the former research and development site that had been explored by Nubeth, and over two ore bodies that have been identified for potential uranium recovery (Strata, 2011b).

Vegetation

Vegetation at the Ross Project area was sampled by the Applicant in cooperation with the neighboring landowners after a field study to determine the best vegetation-sample locations was conducted in 2010. Eleven vegetation samples were ultimately collected at downwind locations and near the potential locations of the CPP and surface impoundments as well as along the major ore bodies in the mid- to late summer of 2010.

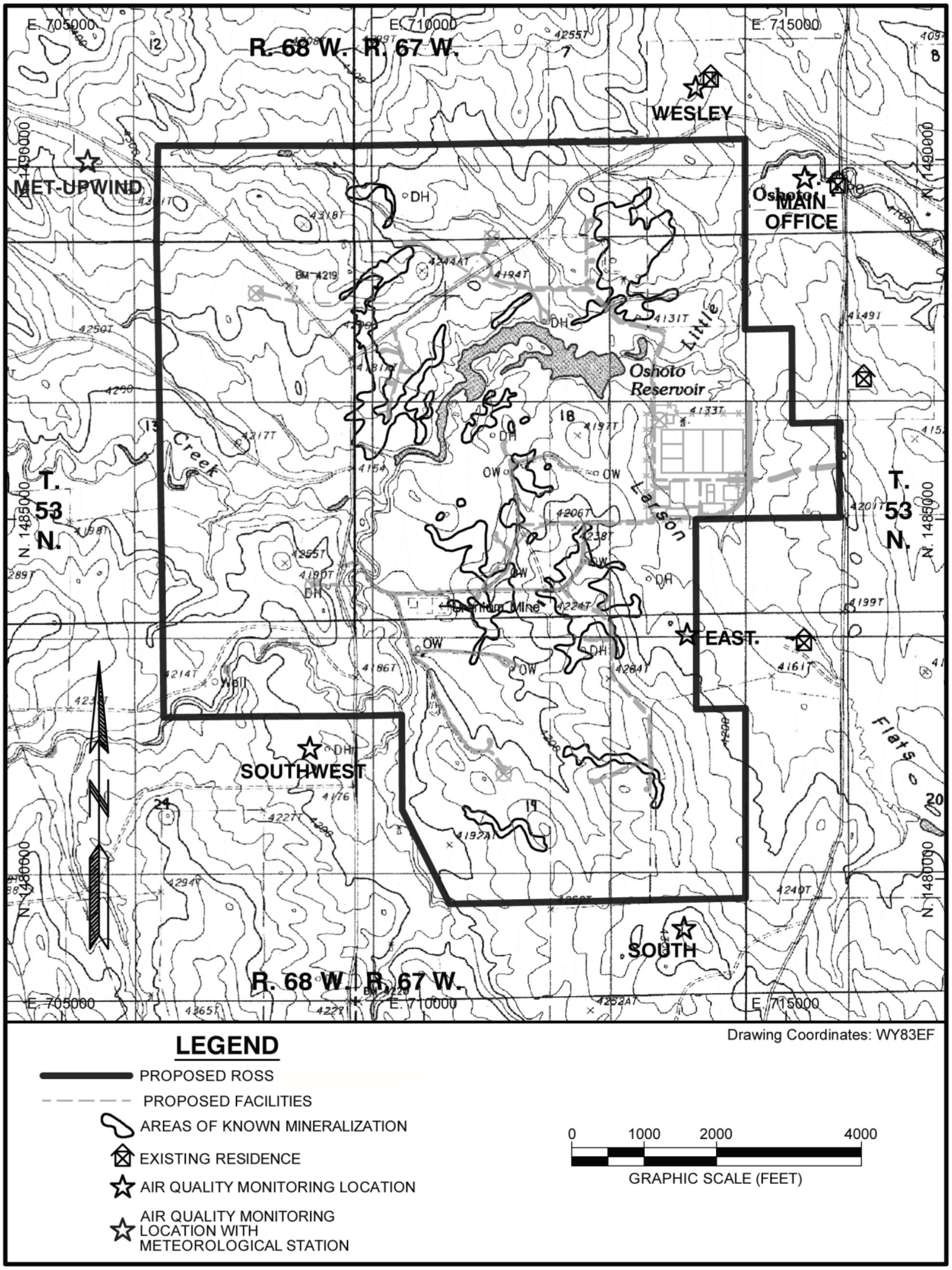
Animals

Livestock

Beef from locally raised cattle were sampled in cooperation with local landowners. Because horses are not raised in the area for human consumption, no horse-meat samples were obtained. A single beef sample was collected in July 2010 (Strata, 2011b).

Wildlife

Based on the wildlife surveys discussed in SEIS Section 3.6, the only wildlife potentially hunted at or near the Ross Project area for human consumption are deer and pronghorn antelope. One deer-meat sample was obtained from a local landowner who had hunted the deer in the Project’s vicinity during the 2010 hunting season (Strata, 2011b).



Source: Strata, 2011b.

Figure 3.24

Air-Particulate Sampling Stations at Ross Project Area

Fish

A single composite sample from 99 fish that were caught at the Oshoto Reservoir was collected. Although it is reported by local landowners that fish from the Reservoir are not consumed by humans (Strata, 2011b), this sample was nonetheless submitted for analysis in September 2010.

Direct* (*Gamma*) *Radiation

Gamma Field Survey

A field survey performed by a contractor for the Applicant was conducted during July 19 through 22, 2010. During this survey, a total of 80,833 points were surveyed for gamma radiation (Strata, 2011a). In addition, ten soil samples were obtained for an evaluation of the potential relationship between radiation levels and radium concentrations in the corresponding soils (Strata, 2011b). The survey was performed according to the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (NRC, 2000), which is the generally accepted methodology for gamma field surveys.

Long-Term Gamma Study

A long-term study to measure long-term gamma radiation by thermo-luminescent dosimeters (TLDs) was implemented by the Applicant at the same time the radon monitoring stations were established. Ultimately, a total of 17 TLDs (and 2 controls) would be installed around the Ross Project area to measure quarterly gamma exposures.

3.12.2 Public and Occupational Health and Safety

The exposure of members of the public to hazardous chemical is regulated by the EPA and by the State of Wyoming under a variety of statutes and regulations. The NRC, however, has the statutory responsibility, under the *Atomic Energy Act* (AEA), to protect public and occupational health and safety with respect to radioactive materials and radiation exposures. NRC regulations at 10 CFR Part 20 specify annual radiation dose limits to members of the public of 1 mSv [100 mrem] TEDE and 0.02 mSv [2 mrem] per hour from any external radiation sources (see SEIS Section 3.12.1 for a discussion of the units of radiation dose) (10 CFR Part 20). The existing public and occupational health and safety concerns that exist at the Ross Project area today, where it currently presents minimal chemical and radiation exposures, are discussed below.

3.12.2.1 Public Health and Safety

A factor in any assessment of risks to public health and safety, including both chemical and radiation exposures, is the proximity of potentially impacted populations and the nearest receptors. As described in SEIS Section 3.2, the Ross Project area is located in a sparsely populated area of western Crook County (Strata, 2011a). The nearest community is Moorcroft, Wyoming, 35 km [22 miles] to the south, with an estimated population of approximately 1,000 persons. The unincorporated town of Oshoto which is adjacent to the Ross Project area has only a very small population (approximately 50 persons). There are no residences on the proposed Ross Project area; however, within 3 km [2 mi], there are 11 residences with approximately 30 residents. The nearest residence to the Ross Project's boundary is approximately 210 m [690 ft] away, and the nearest residence to the CPP is about 762 m [2,500 ft] away (see SEIS Sections 3.2 and 3.8).

In addition, access to the Ross Project by non-local members of the public is very limited because much of it is privately owned land; there are few public roads that enter the area; and there are no actual public attractions or recreational activities within the Ross Project area or its immediate environs. Moreover, as described in SEIS Section 3.12.1, the hazardous substances known to be present at the Ross Project area are crude oil, associated oil-contaminated water and trash, propane and methanol, and, potentially, polychlorinated biphenyls (PCBs) (Strata, 2011a). Thus, there are very limited non-radiological public health and safety concerns at the Ross Project area because there are: 1) few close residential receptors, all of whom are located offsite; 2) few, if any, members of the public who can access the Project area; and 3) very few hazardous materials are present.

With respect to the existing radiological hazards that are present at the Ross Project area, the same limitations exist as described above for nonradiological hazards: few nearby residents, no public access, and few sources of radiation exposure. The pre-licensing, site-characterization results presented in Table 3.21 indicate exposures to only common background radiation as described in SEIS Section 3.12.1. Soil results presented in Table 3.21 indicate the radionuclide concentrations in soils that are naturally occurring, including the decay products (i.e., progeny) of the naturally occurring uranium, thorium, and radon. The surface- and ground-water pathways, as described above (see SEIS Section 3.12.1), yield little if any radiation exposure to those receptors located offsite because the analytical results of surface- and ground-water samples indicate concentrations of radionuclides that are essentially at or below the respective detection limits and/or below regulatory guidelines. Finally, animal samples indicate limited concentrations of naturally occurring radionuclides. Thus, there are very limited public health and safety concerns at the Ross Project area as it is currently characterized.

3.12.2.2 Occupational Health and Safety

Nonradiological

Occupational health and safety (i.e., industrial safety) is regulated by the State of Wyoming under the Occupational Safety and Health Administration Program. However, occupational health and safety hazards within the Ross Project area are limited by the existing land uses, which are primarily grazing, agriculture, and oil production (see SEIS Section 3.2). Known occupational health and safety concerns include common physical health and safety hazards as well as, potentially, exposures to hazardous substances. Occupational exposures could include normal, industrial, airborne hazardous substances associated with servicing equipment (e.g., vehicles); fugitive dust generated by agricultural activities and by access road use during well-drilling activities; and various chemicals used in agriculture or during oil extraction.

A common type of occupational hazard includes injuries and illnesses. According to the Wyoming Department of Workforce Services (WDWS), the most common lost-day injuries among mineral-extraction workers, including oil-production workers (currently the only type of consistent occupational worker present at the Ross Project area), were from strains and sprains that often resulted from slips, trips, falls, or lifting. The Bureau of Labor Statistics (BLS) compiles annual reports of incidence rates of nonfatal occupational injuries and illnesses by industry and case types. The most recent reports include data from 2009 and 2010. For the category “uranium-radium-vanadium ore mining,” annual average employment is given as 1,000 and 900 in 2009 and 2010, respectively. For both years, no total recordable cases either during work or not during work were reported (BLS, 2009; BLS, 2010).

Radiological

The occupational standard promulgated by the NRC is 50 mSv [5 rem] for TEDE over the entire human body (other limits pertain to exposures other than whole body). In addition, all radiation exposures are to be limited to “as low as reasonably achievable” (ALARA). However, only a few pre-construction activities are currently taking place at the Ross Project area—activities such as drillhole plugging and abandonment, monitoring well installation, and environmental monitoring sample collection by the Applicant’s personnel. As the pre-licensing baseline data demonstrate (Strata, 2011a), little radioactivity is available to come into contact with these personnel at the Ross Project area today. As a result, there is currently only a small occupational exposure to radiation (i.e., there are few personnel to be exposed and few sources of radioactivity that yield measureable doses).

3.13 Waste Management

Few wastes are currently generated at the Ross Project area, either liquid or solid. Those that are generated are described below.

3.13.1 Liquid Waste

Sources of liquid waste generated at the Ross Project area currently include uranium-exploration drilling, monitoring wells drilling and development, and oil-production facilities (Strata, 2011a).

Drilling the many exploration drillholes on the Ross Project generates drilling fluids and muds (i.e., cuttings). These wastes are classified as technologically enhanced, naturally occurring radioactive materials (TENORM); they are defined by EPA as “[n]aturally occurring radioactive materials that have been concentrated or exposed to the accessible environment as a result of human activities such as manufacturing, mineral extraction, or water processing” (EPA, 2008). Drilling wastes (i.e., fluid, muds, cuttings) are collected and disposed of by the Applicant in onsite excavated pits, or mud pits, that are dug for this specific purpose pursuant to the various EPA regulations governing TENORM, such as those in 40 CFR Part 192. They are allowed to evaporate and dry, and then the dried pits are reclaimed according to WDEQ/LQD requirements, usually within one construction season.

Drilling fluids and muds similar to those created during uranium-exploration drilling are also generated during the Applicant’s drilling of its preconstruction monitoring wells and drillholes that it is using to support its license application to the NRC (Strata, 2011a). These fluids are contained and evaporated in mud pits the same as those above, which are constructed adjacent to the drilling pads (Strata, 2011b). An average of 23, 000 liters [6,000 gallons] of ground water along with 12 m^3 [15 yd^3] of drilling muds, are produced during the development and sampling of monitoring wells (Strata, 2011b).

Ground water has also been produced during well tests conducted to characterize aquifer properties (Strata, 2011a). This TENORM water is discharged under a temporary WYPDES Permit No. WYG720229 (WDEQ/WQD, 2011).

Crude oil and water used in its production could be present at the three oil-producing wells on the Ross Project area. These wastes are categorized by EPA as “special wastes” and are exempt from the Federal hazardous waste regulations under Subtitle C of the *Resource Conservation and Recovery Action* (RCRA).

3.13.2 Solid Waste

Few solid wastes are currently generated at the Ross Project area; no AEA-regulated wastes are currently generated. The solid wastes currently generated include predominantly miscellaneous trash from the existing agricultural and oil-production activities that currently take place at the Project area. Agricultural wastes are either disposed of at private landfills or at the local state-permitted landfill in Moorcroft; no private landfills have been identified at the Ross Project area (Strata, 2011a).

Oil-production solid wastes, such as rags contaminated by oil, propane, or methanol, are “special wastes” according to EPA regulations (i.e., they are generated in the production of crude oil) and are exempted from the EPA’s hazardous waste regulations under Subtitle C of RCRA (Strata, 2011a). There is one existing stockpile of discarded oil-production tubing that has been identified on the Ross Project area.

3.14 References

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